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THIRD SERIES FOUNDED BY EDWARD JACKSON

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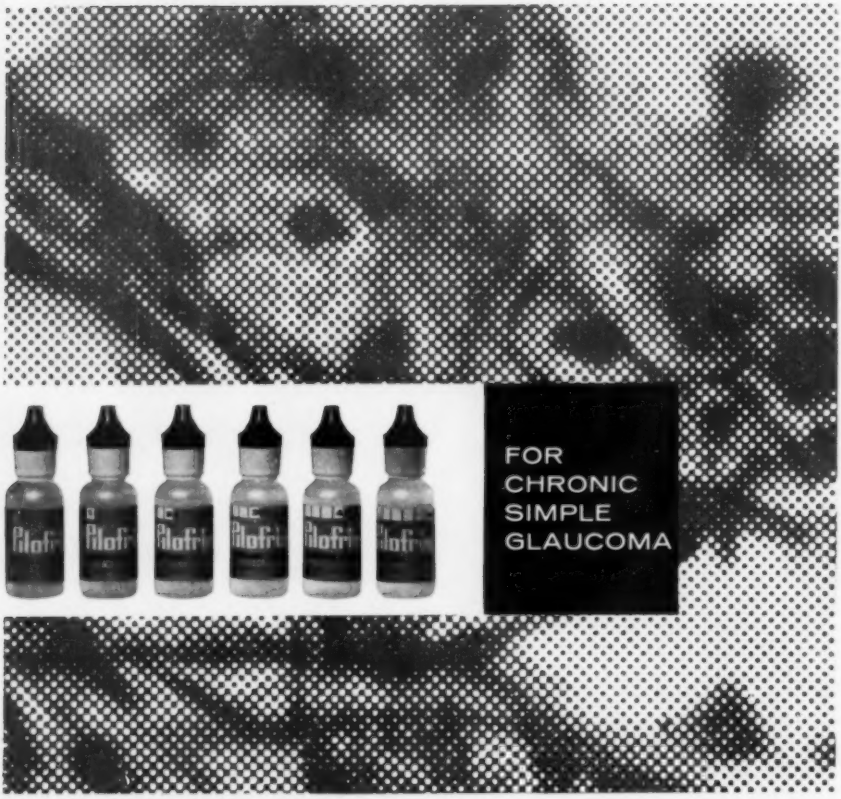

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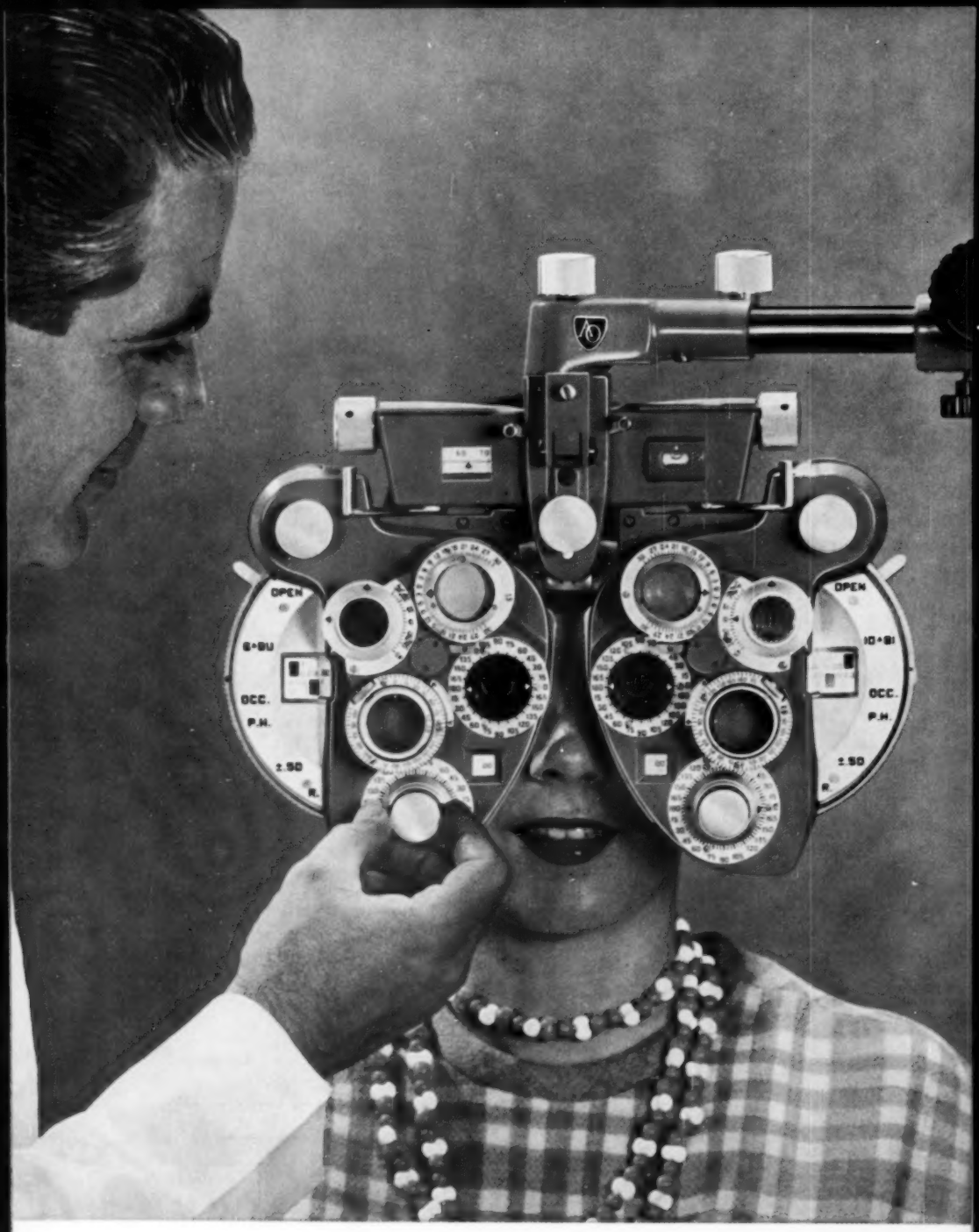

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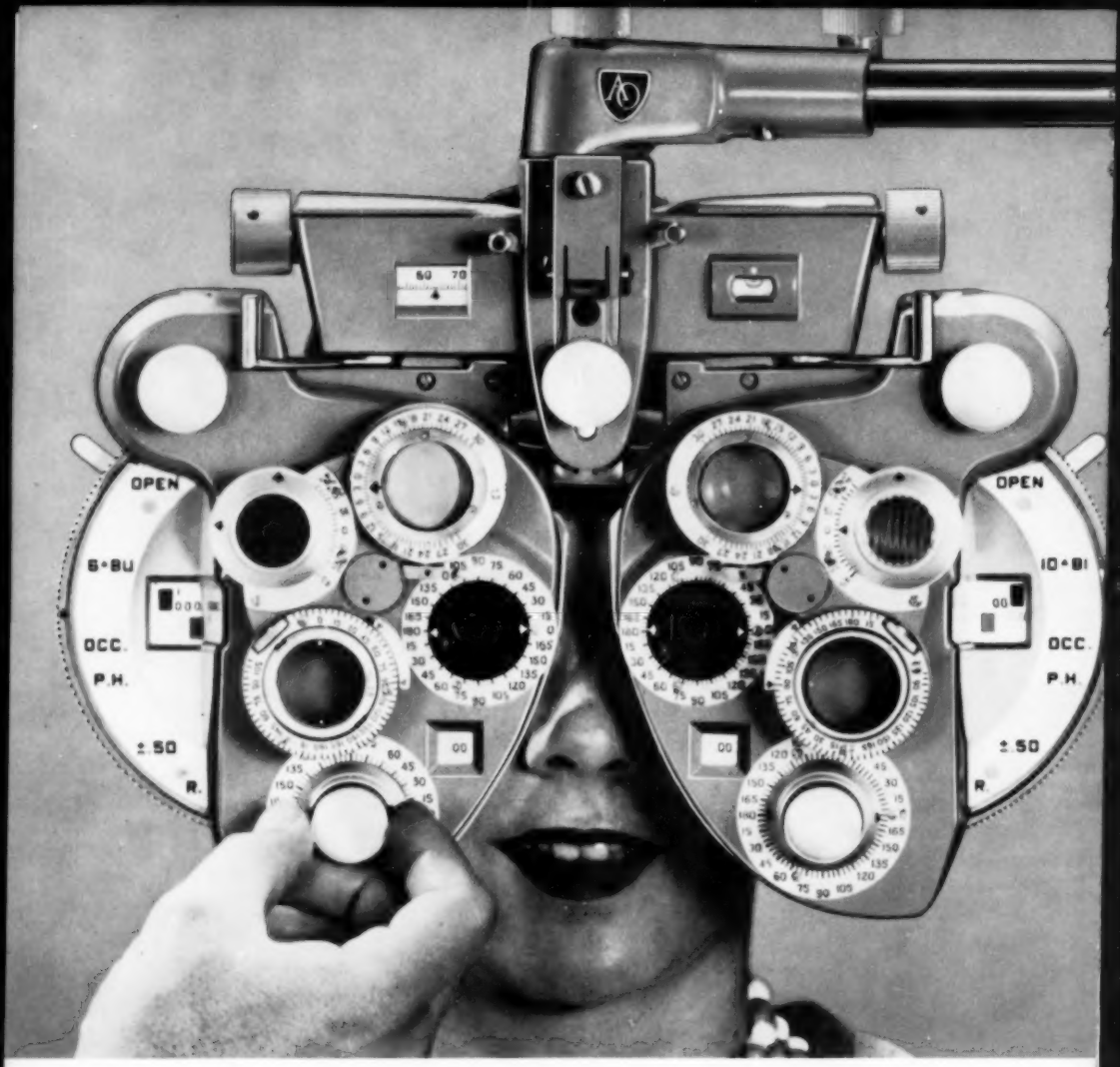

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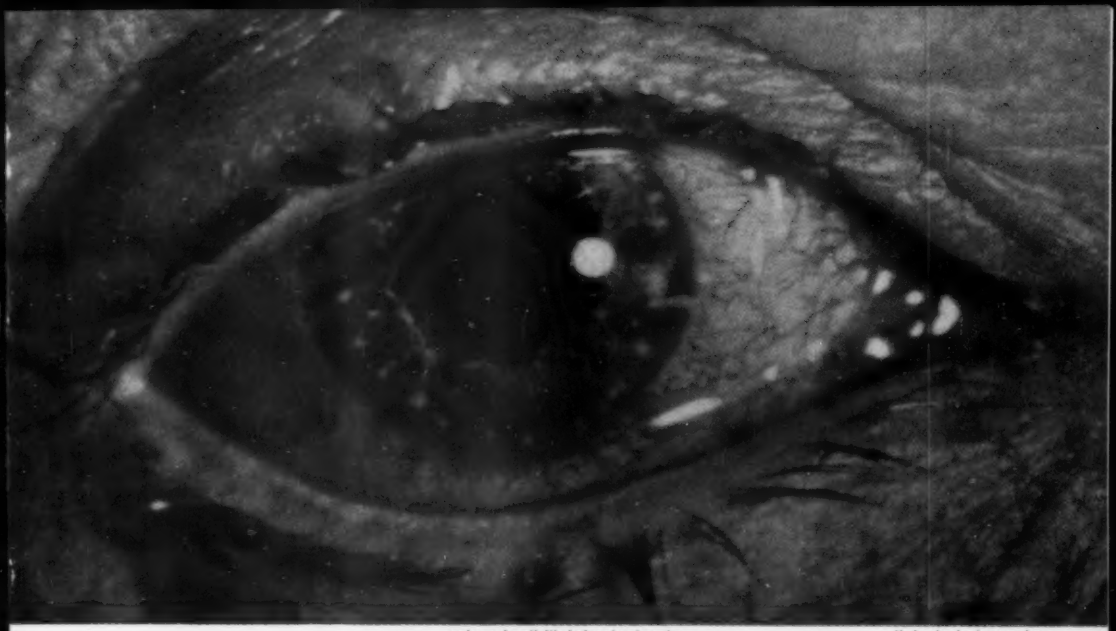

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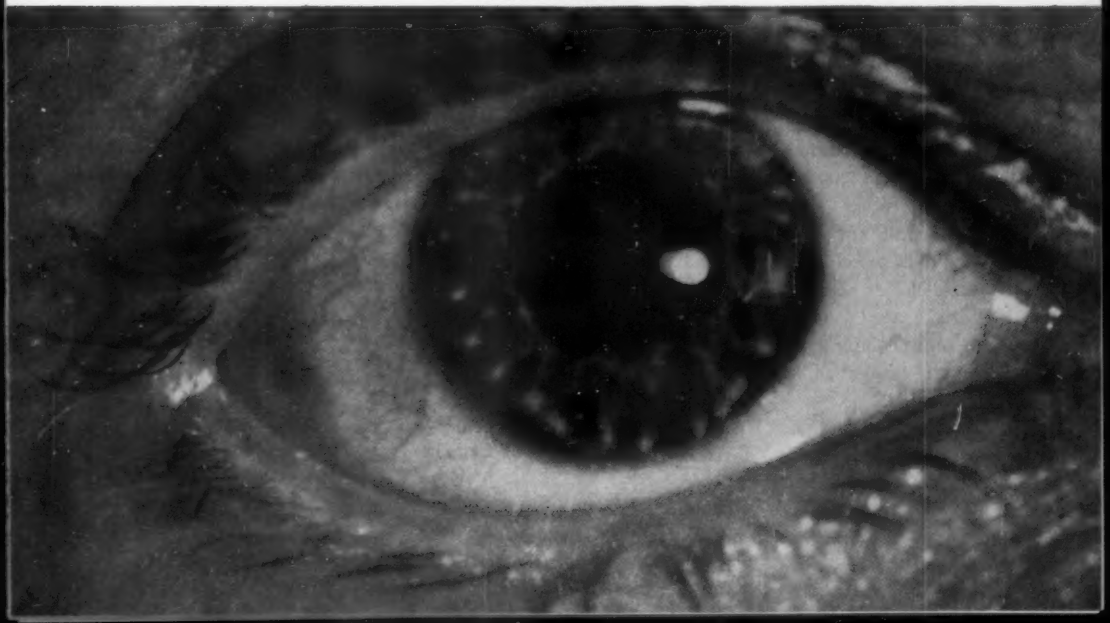

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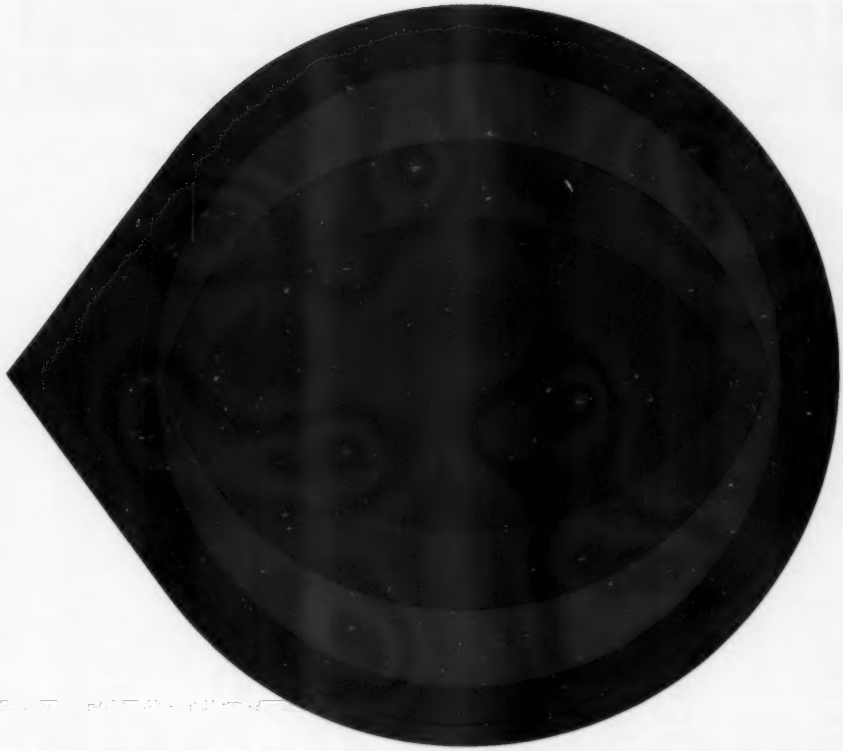

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REFERENCES: 1. Fremont-Smith, F., and Forbes, H. S.: Arch. Neurol. & Psychiat. *18*:550 (Oct.) 1927. 2. Javid, M., and Settlage, P.: J.A.M.A. *160*:943 (March 17) 1956. 3. Javid, M.; Settlage, P., and Monfore, T.: Surgical Forum *7*:528, 1957. 4. Javid, M., and Settlage, P.: Tr. Am. Neurol. A. 1957, pp. 151-153. 5. Javid, M., and Anderson, J.: Surgical Forum *9*: 1959. 6. Javid, M.: Surg. Clin. North Am. *38*:907 (Aug.) 1958. 7. Javid, M., and Anderson, J.: J. Lab. & Clin. Med. *53*:484 (March) 1959. 8. Stubbs, J., and Pennybacker, J.: *Lancet 1*:1094, 1960. 9. Tench, J. H.; Javid, M., and Gilboe, D.: Anesthesiology *21*:117 (Jan.-Feb.) 1960. 10. Javid, M., and Davis, M.: Scientific Exhibit No. 922, A.M.A. Annual Meeting (June) 1960.

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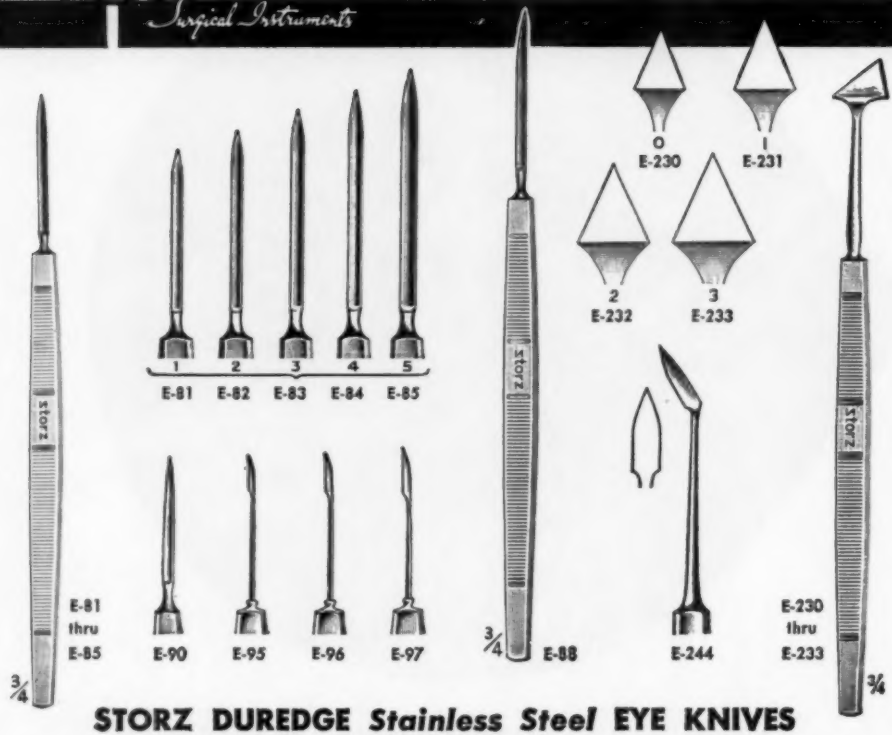

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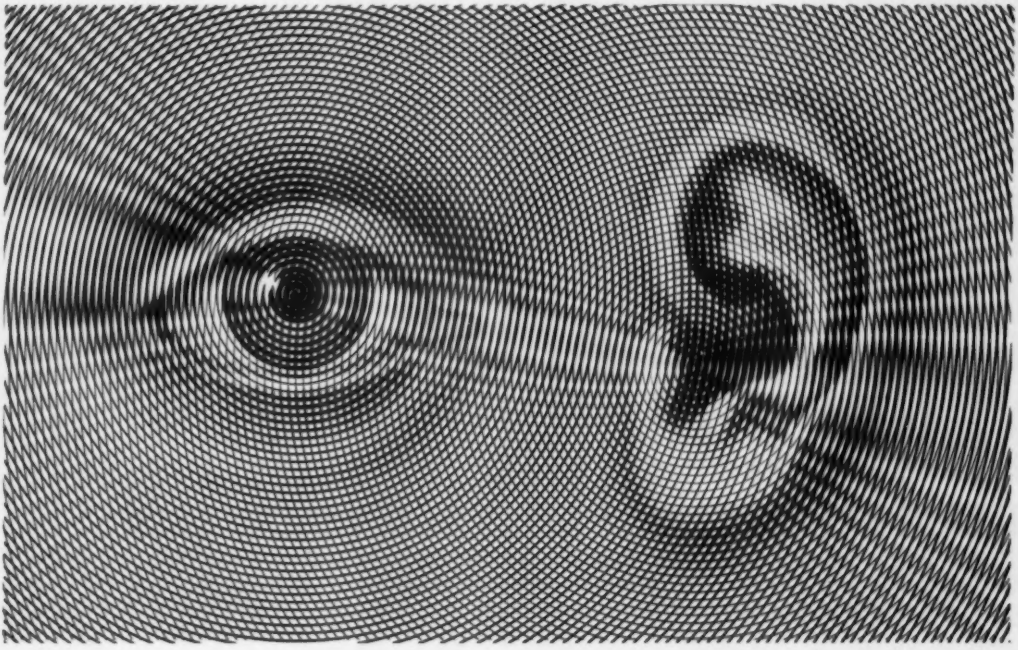

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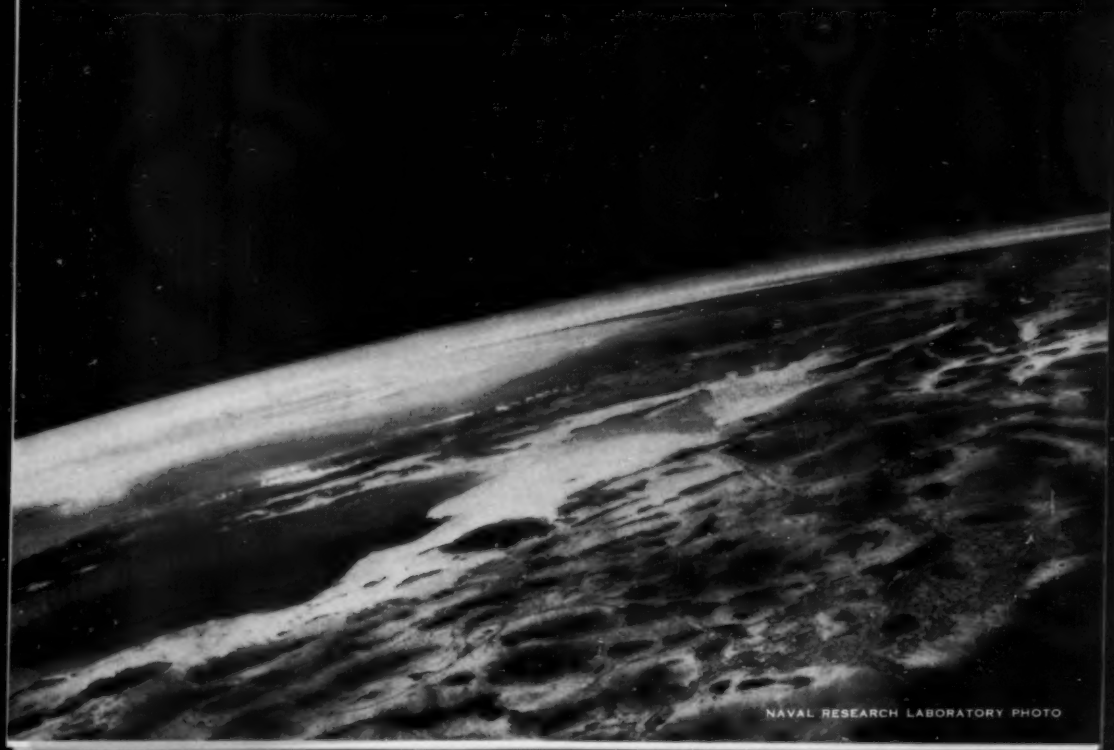

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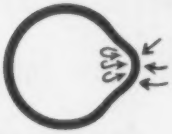

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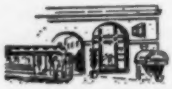

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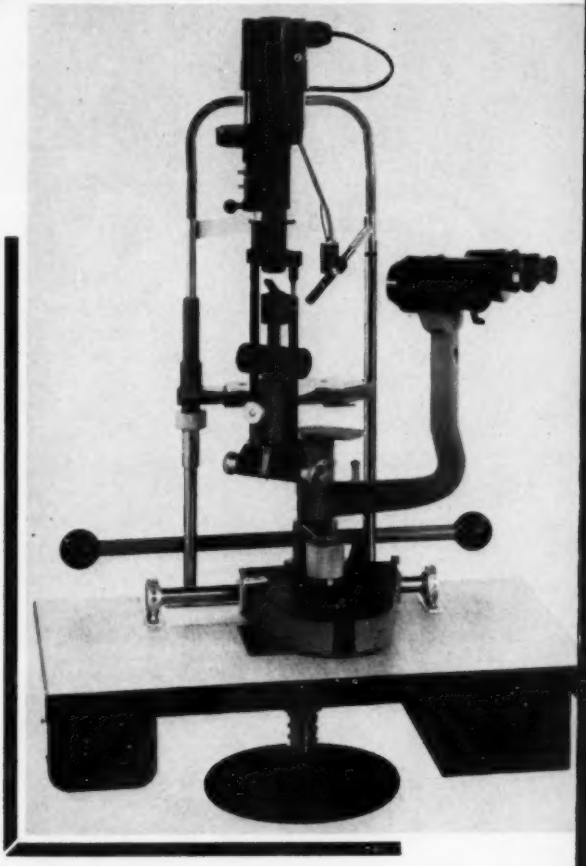

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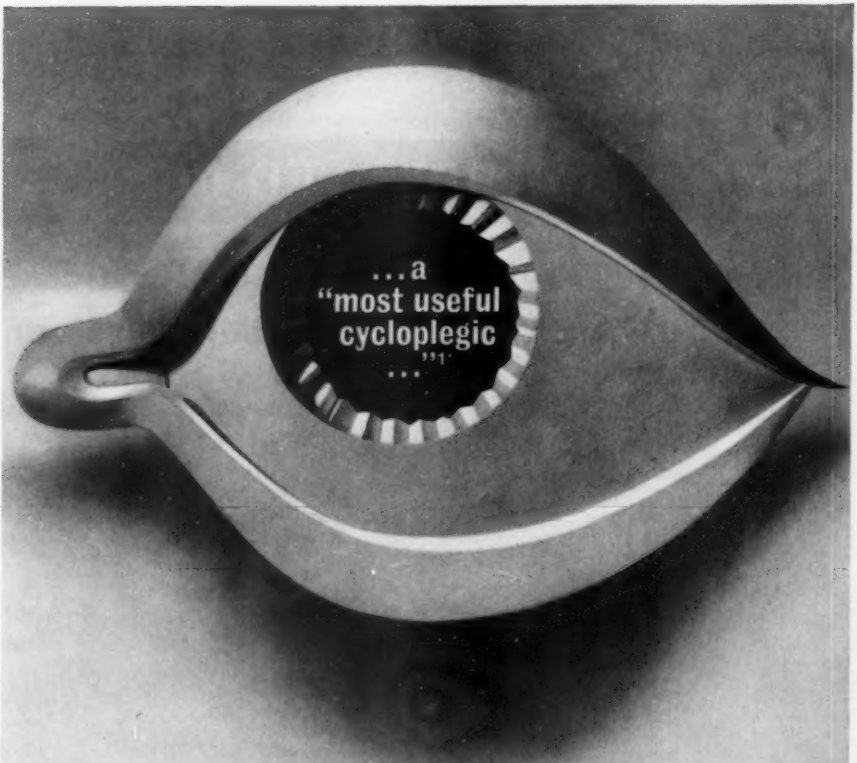

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References: 1. Gordon, D. M., and Ehrenberg, M. H.: *Am. J. Ophth. 38*:831, 1954. 2. Prangen, A. De H.: *A.M.A. Arch. Ophth. 18*:432, 1937. 3. Ehrlich, L. H.: *New York J. Med. 53*:3015 (Dec. 15) 1953. 4. Miles, P. W.: *Missouri Med. 56*:1243, 1959. 5. Leopold, I. H.: in Abstract of Discussion: *A.M.A. Arch. Ophth. 51*:471 (April) 1954.

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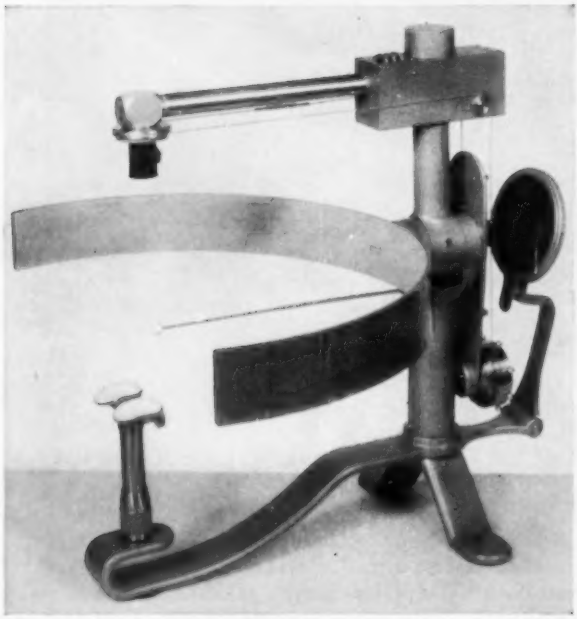

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- two topical dosage forms: 0.1% solution in peanut oil, in 5-cc. vials; 0.025% ointment, in 3.5 Gm. tubes

also available: **DARANIDE** *for oral control of intraocular pressure, 50 mg. tablets*

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For additional information, write Professional Services, Merck Sharp & Dohme, West Point, Pa.

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Topical hydrocortisone provides symptomatic relief of edema, pain and photophobia, and curbs neovascularization, while polymyxin B and neomycin eradicate most pathogens invading the eye, including Pseudomonas.

'CORTISPORIN'® brand OPHTHALMIC SUSPENSION

Each cc. contains:

'Aerosporin'® brand Polymyxin B Sulfate	10,000 Units
Neomycin Sulfate	5 mg.
Hydrocortisone (1%)	10 mg.

Indicated in bacterial, allergic, vernal and phlyctenular conjunctivitis; blepharitis; episcleritis; iritis; anterior uveitis; interstitial, sclerosing, postoperative or acne rosacea keratitis; chemical and thermal burns of the cornea.

Application: Apply 1 or 2 drops in the affected eye every 3 or 4 hours, depending upon the severity of the condition. In acute conditions, the drops may be used at more frequent intervals, if required.

Caution: Not recommended for herpes corneae (dendritic corneal ulcers) or conditions involving the posterior segment of the eye.

Available in bottles of 5 cc. with sterile dropper.

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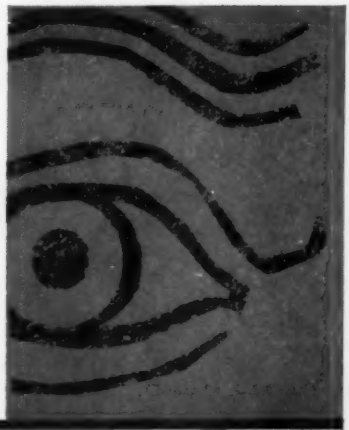

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CONTACT LENSES

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CONTAINS: Boric Acid, Sodium Chloride, Potassium Chloride, Sodium Carbonate. Preserved with Benzalkonium Chloride U.S.P. 1:15,000.

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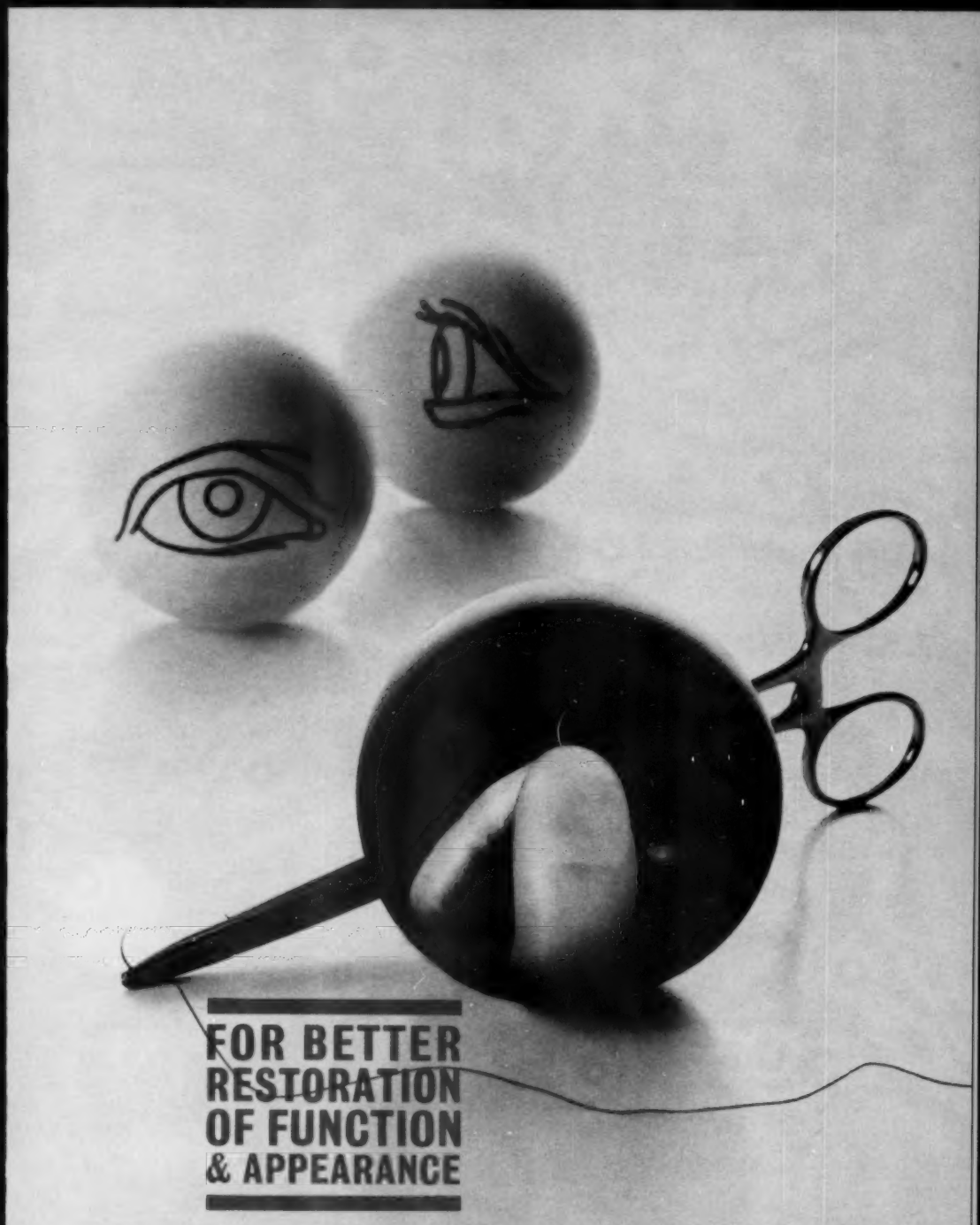

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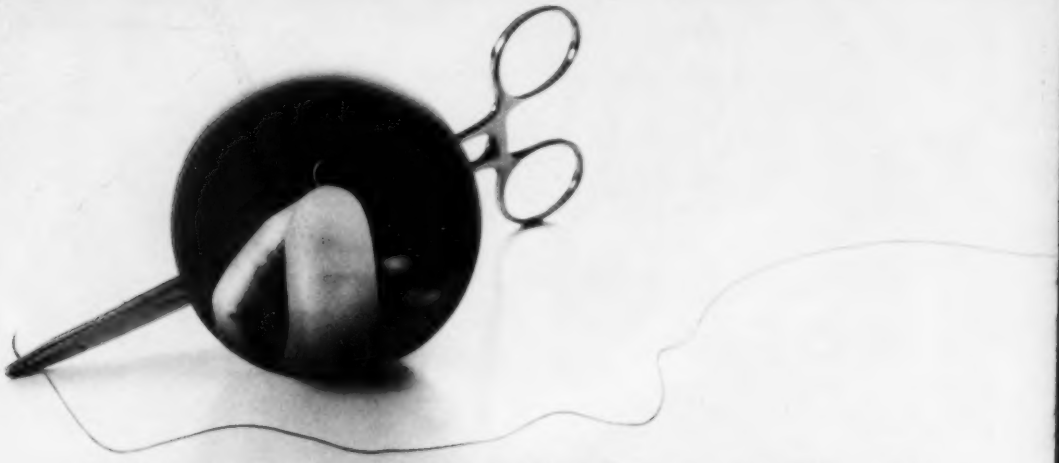

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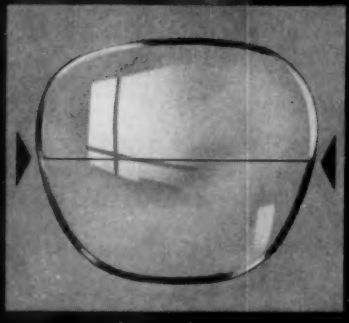

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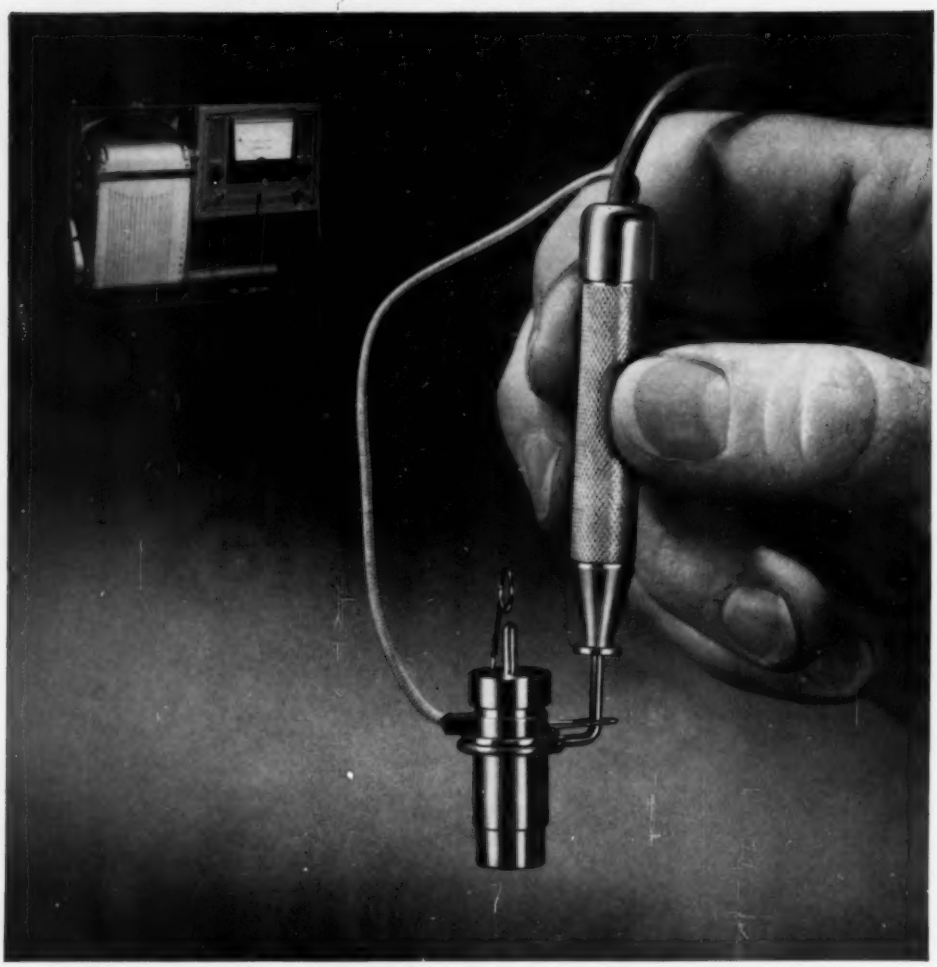

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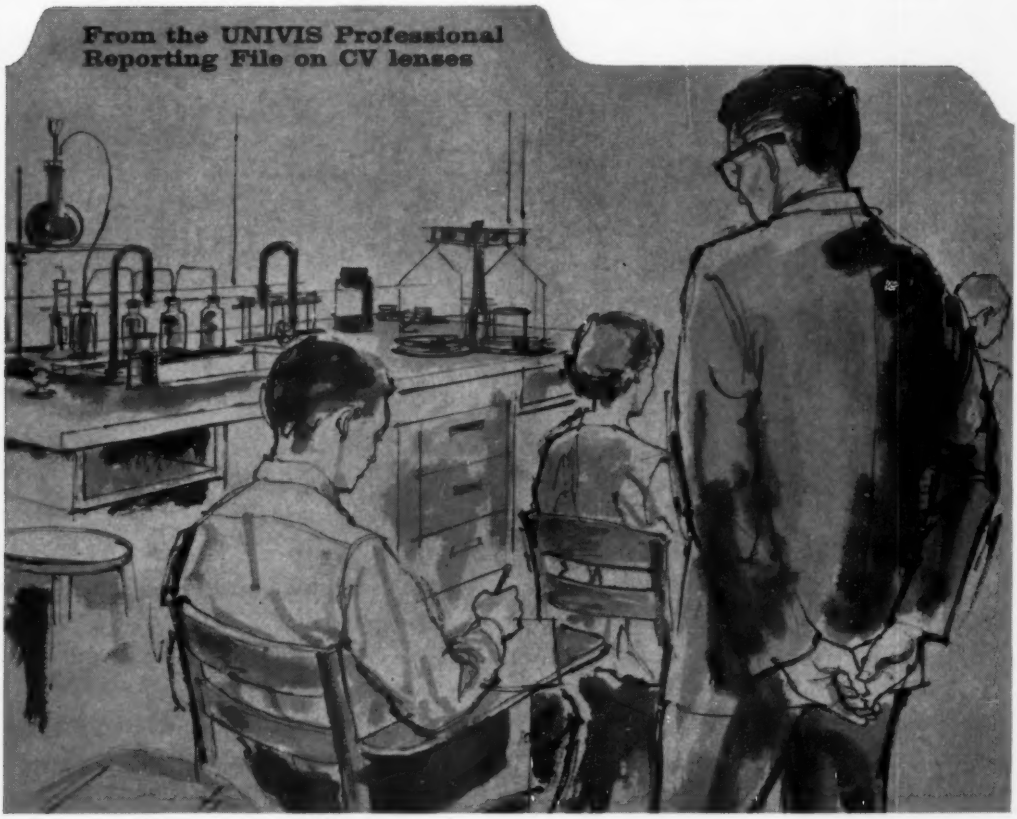

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TABLETS AND AMPULS

1. *Am. J. Digest. Dis.* 22:5, 1955.
2. *Southwestern Med.* 40:120, 1959.
3. *Am. J. Ophth.* 42:771, 1956.
4. *M. Times* 84:741, 1956.

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The CYCON Contact Lens successfully minimizes these problems:

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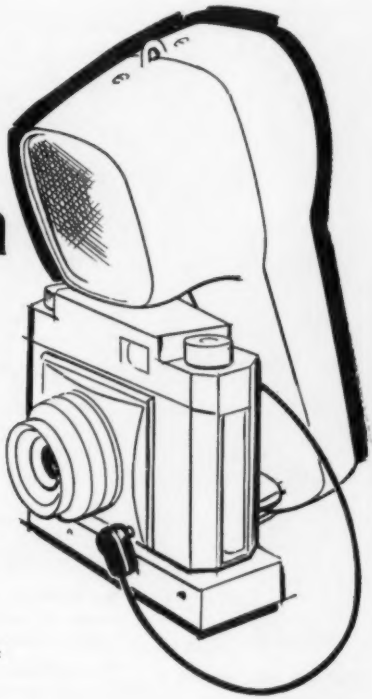

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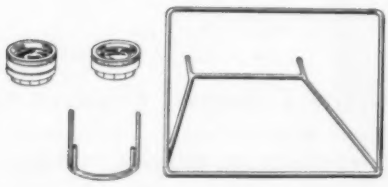

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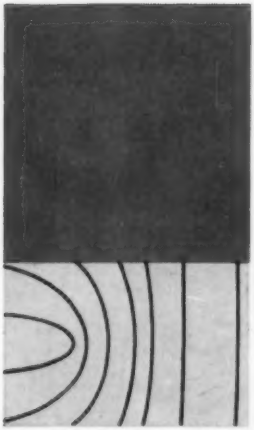

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WHAT CATARACT LENS IS BEST? ? ?

Different types of cataract bifocals produce markedly different effects in weight, appearance and optical performance. Studying the various types of cataract bifocals most commonly used, the following is our opinion:—

In many cases the ground lenticular is to be recommended. Where you must use a large lens, one with large amounts of decentration, or one with an eccentric shape, it is the only practical form to keep weight at a minimum. However, this bifocal form accentuates the strength of the lens because of the reflections of the intersection of lenticular and plano fields. Further, a fused segment always causes *some* chromatic aberration and distortion.

Fused lenticulars do improve the appearance somewhat—they save about 3 to 3.5 diopters in the distance portion of the lens.

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AMERICAN JOURNAL OF OPHTHALMOLOGY
SERIES 3 · VOLUME 51 · NUMBER 2 · FEBRUARY, 1961

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ABSTRACTS

Anatomy, embryology, and comparative ophthalmology; General pathology, bacteriology, immunology; Vegetative physiology, biochemistry, pharmacology, toxicology; Physiologic optics, refraction, color vision; Diagnosis and therapy; Ocular motility; Conjunctiva, cornea, sclera; Uvea, sympathetic disease, aqueous; Glaucoma and ocular tension; Crystalline lens; Retina and vitreous; Optic nerve and chiasm; Neuro-ophthalmology; Eyeball, orbit, sinuses; Eyelids, lacrimal apparatus; Tumors 344

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EXENTERATION OF THE ORBIT AND REPAIR BY TRANSPLANTATION OF THE TEMPORALIS MUSCLE*

ALGERNON B. REESE, M.D., AND IRA S. JONES, M.D.
New York

INTRODUCTION

In a previous paper one of us (A.B.R.) reported a technique for repair of the exenterated orbit by utilization of the temporalis muscle. Since that time the technique has proved its worth, and has now been used in a total of 20 cases.

The operation gives a cosmetic result much more acceptable to the patient than the previously practiced simple exenteration with a split-skin graft. Furthermore, after we have thought tumor recurrence unlikely, we have been able to reconstruct the socket for a prosthesis in two cases. An additional advantage has been that no postoperative dressings are necessary after a week to 10 days.

More experience with the operation has led to some improvements in technique and likewise in our results. The present technique employed follows.

TECHNIQUE OF TEMPORALIS MUSCLE TRANSPLANT (DIAGRAM A, FIGS. 1-8)

The upper and lower lids are halved by an incision with a scalpel through the gray line from one end of the lid to the other (fig. 1). At the extremities of the lids this incision may be completed with scissors. This halving of the lids leaves, anteriorly, the cilia and skin, and, posteriorly, the tarsus, orbicularis, conjunctiva, palpebral muscle, and fascial planes. This division of the upper and lower lids is carried out to the orbital margin above and below.

A skin incision is made from the external canthus horizontally for from two to three centimeters. The dissection of this skin is continuous with that of the skin of the upper and lower lids and is carried out above and below to expose the entire region over the temporalis muscle. When these upper

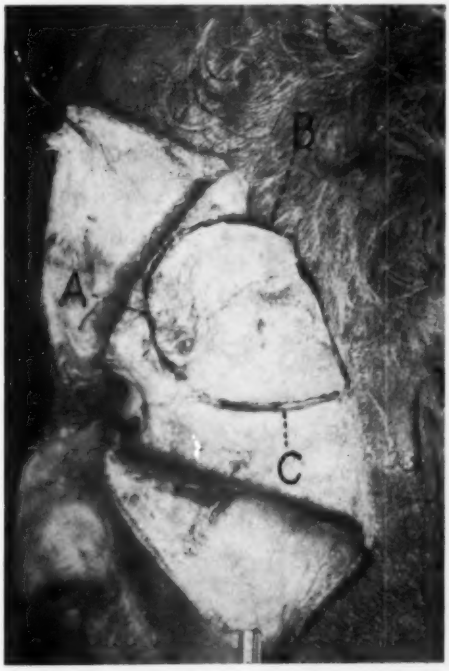

Diagram A (Reese and Jones). Cadaver dissection to show area of temporalis to be transplanted. The skin flaps have been reflected in the fascial plane overlying the temporalis muscle and the portion of the muscle to be utilized is outlined. (A) Beginning of the muscle dissection. (B) Extension of incision around thin edge of muscle. (C) Separation of thick fascia from zygoma.

* From the Institute of Ophthalmology of the Presbyterian Hospital and Columbia University, College of Physicians and Surgeons.

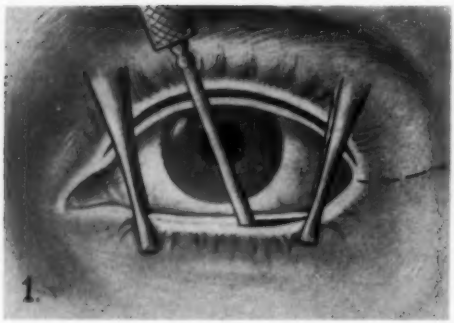

Fig. 1 (Reese and Jones). Modified exenteration procedure which is used when temporalis muscle transplantation is to be done. The upper and lower lids have been halved, leaving, anteriorly, the cilia and skin, and, posteriorly, the tarsus, orbicularis, conjunctiva, palpebral muscle, and fascial planes.

and lower flaps, including the skin of the upper and lower lids and the skin of the temporal region, are now reflected, the entire orbital cavity is exposed together with a wide area in the temporal region.

The next step is to incise the periosteum around the entire orbital circumference and to perform an exenteration, including the periosteum.

Next, an incision is made in the deep fascia along the origin of the temporalis muscle. The deep fascia with its underlying temporalis muscle is reflected from the temporal fossa. The fascia is incised from the upper margin of the zygomatic process where it is adherent.

Fig. 2 (Reese and Jones). The margins of the posterior half of the lid have been sutured together by a double-arm suture in the interest of easier manipulation when the exenteration is done. A horizontal incision extending from the external canthus temporally exposes the lateral bony wall and the temporal fossa.

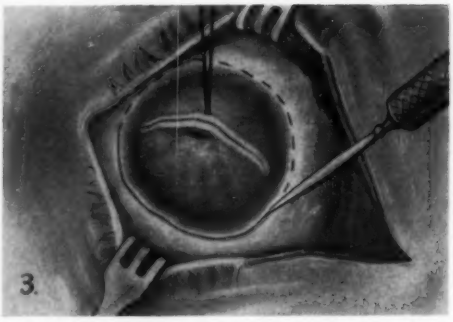

Fig. 3 (Reese and Jones). The periosteum is divided at the orbital rim and the contents are mobilized.

The muscle is dissected down under the zygomatic process to its insertion into the coronoid process of the mandible. The muscle and fascia are freed until they are sufficiently mobile to reach the orbit easily.

With the Stryker saw, a round opening is made in the lateral wall of the orbit. This is enlarged with ronguers, particularly below, but the anterior orbital margin is left. A 20-mm. gold sphere is placed in the apex of the orbit. When the opening in the lateral wall of the orbit has been made sufficiently large, the temporalis muscle and its fascia are passed through the opening into the orbit and sutured to the remaining periosteum in such a way that the muscle and fascia are fanned out to fill uniformly as much of the orbit as possible. The lid margins are approximated with two double-arm catgut sutures. A pressure dressing is applied.

The differences in the technique just described and in that used earlier are as follows: The orbital periosteum is not preserved. This was originally used for a suture anchor, but the cut edges of periosteum at the orbital rims are sufficient. About two thirds of the temporalis muscle was formerly used to obtain enough tissue to fill the orbital defect. The present technique utilizes about half of the muscle. Part of the differ-

Fig. 4 (Reese and Jones). The position of temporalis muscle to be used as a graft is outlined.

Fig. 5 (Reese and Jones). After exenteration of the orbit, the anterior half of the temporalis muscle is mobilized from its fossa and cut free from the zygoma.

ence is in the use of a larger gold sphere, but most of the difference is due to obtaining more of the heavy muscle fascia from its attachment to the zygoma and to a freer mobilization of the muscle.

Technique of socket restoration

When sufficient time has elapsed after exenteration of the orbit so that a recurrence seems unlikely, then the socket may be restored. This has been done on two of the patients in the present report. The technique is as follows:

A knife cut is made between the two rows of cilia to a depth of two mm. The length of the incision and the placement of the lateral and medial ends are determined with the palpebral fissure of the fellow eye in view so that a good match is obtained. At the two-mm. depth of the incision the surface of the underlying graft fascia is found and the lids can be separated from it by sharp and blunt dissection. This is carried above and below to the orbital rim. Two large plastic conformers are sutured back to back. A split-thickness skin graft measuring about 5.0 by 8.0 cm. is taken from the abdomen with the Paget dermatome. This is placed around the previously prepared conformers with the cut surface out. The edges of the skin graft should come together on the front surface of the plastic form. This is then placed under the lids and the upper and lower lid edges are drawn firmly toward each other. This is to push the skin graft as deeply into the fornices as possible. Excess protruding skin may be trimmed off. The conformers are removed in five to seven days, and a prosthesis can be fitted when all devitalized skin has been excised.

Technique of exenteration with retention of the conjunctiva

If the condition for which the exenteration is being done does not involve conjunctiva, then the technique can be modified. This has been done on one patient. The technique varies in the following manner. Instead of the lids being split in the gray line, the entire thickness of each lid is preserved. The conjunctiva is divided at the limbus and reflected to the fornices. The knife cuts to the orbital rim are then made under the

Fig. 6 (Reese and Jones). Lateral wall of the orbit is perforated by a trephine or a straight saw. The opening is then enlarged.

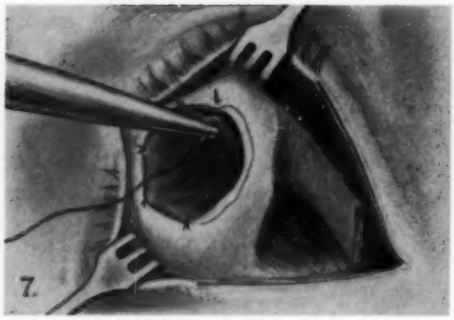

Fig. 7 (Reese and Jones). The temporalis muscle and deep fascia are passed through the hole in the lateral wall and sutured to the cut edges of periosteum. A gold or plastic sphere lies behind the muscles.

conjunctiva and the exenteration proceeds in the usual manner. After the temporalis graft has been sutured in place, the conjunctival opening is closed as it would be after an enucleation. A conformer should be used and a prosthesis can be fitted in two weeks.

Presentation of cases

Patient J. C., a white girl, aged seven years, who was presented in the previous paper, was first seen nine days after the referring doctor had removed an orbital mass from the upper part of the left orbit through a conjunctival approach. Sections of the mass revealed a rhabdomyosarcoma so that prompt exenteration with temporalis muscle graft was carried out. Follow-up examination revealed a satisfactory cosmetic result with no sinking in the temporal fossa and an adequate number of cilia in the upper lid. It is now one year postoperatively and the patient will have a socket restoration at a future

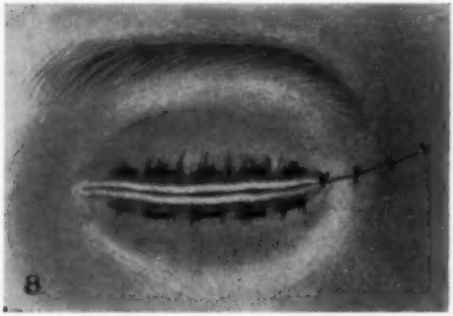

Fig. 8 (Reese and Jones). The remaining anterior leaf of each lid is sutured with the borders everted and the skin of the temple is repaired.

Fig. 9 (Reese and Jones). Patient J. C. was shown in previous paper. The present photograph was taken one year after surgery.

date. A photograph taken 12 months after surgery is shown (fig. 9).

Patient S. A., a 50-year-old white man, was first seen because of slight redness of the right eye for one year, double vision for four months, and swelling of three months' duration. Studies including thyroid tests, X-ray films of skull and orbit, hands, and chest were carried out with negative results. The patient was discharged with a diagnosis of exophthalmos due to a pseudotumor or nonspecific granuloma. Fifteen months later the patient was again seen, with sight in his right eye reduced to hand movements at two feet. There was marked vascularity with atrophy of the optic nerve. A Krönlein procedure disclosed a large tumor mass below. This mass was excised and the pathology report was a carcinoma, primary site unknown. Subsequently, an exenteration with a temporalis muscle graft was performed. One year postoperatively no evidence of disease was found. One and one-half years after surgery there was no evidence of disease and the cosmetic result was good. Restoration with prosthesis is to be considered later. Photographs taken 12 months after exenteration are shown (figs. 10 and 11).

Patient B. L., a white woman, aged 47 years, noted a red spot on the conjunctiva of the left eye for 35 years. One year previously it became pigmented and was excised. There was recurrence of

Fig. 10 (Reese and Jones). Patient S. A. Front view taken one year after surgery.

the pigmentation and the lesion was again excised. After one month ptosis was noted. The patient was found to have a three-mm. limbal pigmentation at the 3-o'clock position, ptosis of the left upper lid, and a pedunculated pigmented lesion of the conjunctiva of the left upper lid, three to five mm. in size, at the upper tarsal border. Excision of these lesions was carried out. Microscopic examination showed malignant melanoma of the conjunctiva. Accordingly, an exenteration combined with a temporalis muscle implant was performed. On follow-up two months after the exenteration procedure, a fluctuant abscess in the left upper lid was incised and drained. Three weeks later the abscess was again incised and curetted. Three months postoperatively a biopsy of the left orbit was done. Along with the biopsy specimen taken at all levels, the edges of the sinus tract on the left were also removed for microscopic study and a border-to-border closure of the opening was carried out. The specimens were granulation tissue. Seven months after the exenteration, there was no evidence of disease. The cosmetic result was good with the exception of slight depression in the temporal region. One year postoperatively, there was marked sinking in the temporal fossa with a lump palpated through the lower lid at the orbital margin. One month after this nodule was palpated, a study of biopsy tissue from the lesion revealed recurrence of tumor. The cytology of this tissue showed a high degree of malignancy with many mitotic figures. Since that time, examination at monthly intervals has revealed marked sinking in the temporal region with a progressively downhill course. Four months after last biopsy, there was evidence of pulmonary metastases. A photograph taken three weeks after operation is shown (fig. 12).

Patient R. H., a white woman, aged 53 years, had a pigmented conjunctival lesion on the right which had been excised four times over the previous six years. At the last excision a diagnosis of malignant change in a pigmented nevus was made. The orbit was exenterated and the defect repaired by transplantation of part of the temporalis muscle. Two years after this surgery, the patient remains well with a satisfactory cosmetic result.

Fig. 11 (Reese and Jones). Patient S. A. Photograph taken one year after surgery.

Fig. 12 (Reese and Jones). Patient B. L. shown three weeks after surgery. The minimal amount of reaction should be noted.

Patient J. F., a 36-year-old white man, presented with blurred vision and proptosis of the right eye of six months' duration. A Krönlein operation under general anesthesia with excision of a tumor was performed. Tissue study revealed a hemangio-endothelioma. An exenteration with temporalis graft was advised and was subsequently executed. The patient had an uneventful convalescence and a plastic reconstruction of the fornix with a fitted prosthesis is to be considered at a later date.

Patient R. G., a 38-year-old white woman, complained of protrusion of the left eye of six months' duration and diplopia for three months. Two weeks prior to referral an orbital exploration was carried out through the left upper lid medially. A tumor was palpated at that time but was not biopsied. On examination a round, firm mass could be felt in the upper inner angle of the left orbit. X-ray films showed the left orbit to be larger in all dimensions than the right. Although the patient's main subjective symptom was diplopia, she also had pain in back of the left orbit and had noticed transitory blurred vision. A Krönlein and exploration procedure was carried out. A tumor was palpated nasally. On attempted removal the capsule proved to be fragile and the tumor came out as a friable poorly defined cellular mass. Pathologic sections of tumor tissue indicated a hemangiopericytoma. Accordingly, an exenteration with temporalis muscle graft was performed by means of the usual procedure. An 18-mm. gold-sphere implant was used. The patient had difficulty in opening her mouth one month postoperatively. Two months after operation the patient was reportedly fine except that the gold sphere had extruded through the upper lid.

Patient B. H., a white girl, aged 13 years, had a history of recent episodes of blurred vision in the left eye. Examination revealed a proptosed eye with limitation of motion on upward gaze. Vision was reduced in that eye to counting fingers at one foot. Exploration and biopsy of the left orbit was made through a lateral canthotomy. Study of the mass confirmed the diagnosis of an intraorbital rhabdomyosarcoma. An exenteration was performed with the temporalis muscle graft. On initial fol-

Fig. 13 (Reese and Jones). Patient V. W. Front view of patient taken three months after surgery.

low-up, a good cosmetic result was noted; however, on subsequent visits there was a great deal of sinking of the lids with marked depression in the temporal fossa. Eight months postoperatively, examination revealed recurrence of tumor in the orbit with bone involvement so that no restoration of the socket could be carried out. One year and three months from date of operation, the patient died.

Patient K. T., a 49-year-old white woman, was referred with a history of a nevus of the left bulbar conjunctiva which had been excised elsewhere. The specimen was diagnosed as precancerous melanosis and perhaps early malignancy. One year later examination revealed a recurrence of dark discoloration. Section again was taken and the diagnosis of precancerous melanosis was repeated. Exenteration with temporalis muscle graft was carried out using the usual procedure. A gold sphere was not used. The final pathology report revealed malignant melanoma of the conjunctiva. One month postoperatively, the patient complained of soreness in the jaw and difficulty in opening her mouth. One year postoperatively, considerable sinking in the temporal region was noted.

Patient L. B., a white girl, aged five years, was referred one month after removal of a tumor in the left orbit which was diagnosed as a rhabdomyosarcoma. On examination the eye was found to be markedly proptosed laterally and down due to a firm mass in the orbit which presented itself, for the most part, in the upper lid nasally and at the inner canthus. Accordingly, an exenteration with the temporalis graft was done. Postoperative examination showed no sinking or depression in the temporal region and the patient, three months after exenteration, was well.

Patient V. W., a 14-year-old white girl, was referred with a history of painless swelling of the lids of the left eye. A biopsy had been carried out elsewhere and a diagnosis of rhabdomyosarcoma of the orbit had been made. Accordingly, an exenteration with a temporalis muscle graft was performed. Three months postoperatively, the patient's physical condition was good. Photographs taken three months after surgery are shown (figs. 13 and 14).

Patient I. R., a 33-year-old Puerto Rican woman, was referred with a progressive melanosis of the conjunctiva of the right lower lid, lower fornix, bulbar conjunctiva laterally and above, and palpebral conjunctiva above. A biopsy specimen revealed malignant melanoma of the conjunctiva. An exenteration of the right orbit with temporalis muscle graft was accordingly performed. The cosmetic result of the procedure was excellent on follow-up examination (figs. 15 and 16); however, four months postoperatively, the patient developed enlarged regional lymph nodes which on biopsy proved to contain malignant melanoma. The orbit then began to show evidence of intraorbital growth of tumor tissue and the pressure became so pronounced that an exenteration of the remaining soft tissues in the orbit was carried out. When the patient was last seen, eight months postoperatively, the orbit again contained a fungating mass of pigmented tissue and the melanoma was judged to be inoperable. A photograph taken six months after surgery is shown (fig. 17). The patient has since died.

Patient H. A., a 73-year-old white woman, presented with a history of glaucoma of the left eye of nine years' duration. The eye had recently become painful. On examination the tension on the

Fig. 14 (Reese and Jones). Patient V. W. Side view of patient taken three months after surgery.

Fig. 15 (Reese and Jones). Patient I. R. Front view of patient taken two months after surgery.

left was plus four and there was a left exotropia of 30 diopters. Vision in the left eye was reduced to no light perception and was not improved with correction. The clinical impression was malignant melanoma of the choroid with extraocular extension. An exenteration with temporalis muscle implant was performed in the usual manner. No gold sphere was used. The microscopic diagnosis revealed stromal cell melanoma. On follow-up examination one month postoperatively, the patient complained of some numbness on the left, but had no difficulty in chewing. Five months postoperatively, a negligible depression in the temporal region was noted and there was some numbness over the left forehead. A photograph taken five months after the surgery is shown (fig. 18).

Patient A. G., a 67-year-old man, had a detached retina in the left eye six years previously. The eye became painful and was eviscerated. It proved to harbor malignant melanoma of the choroid. The orbit was exenterated including periosteum. The anterior half of the temporalis muscle was transplanted into the orbit over a plastic sphere. Convalescence is proceeding smoothly.

Patient P. G., a white woman, aged 60 years, had a two-year history of an enlarging spot on the conjunctiva of the right eye. Biopsy showed malignant melanoma. An exenteration including periosteum was done. The anterior half of the temporalis muscle was transplanted into the orbit over a gold sphere. Convalescence was uneventful and the present state of the patient is satisfactory.

Patient A. C., a white man, had an enlarging tumor under the left upper lid for two months. Biopsy showed this to be malignant melanoma of the conjunctiva. An exenteration including periosteum was done. Part of the temporalis muscle was transplanted into the orbit over a gold sphere. Convalescence was uneventful. Five months later the cosmetic result was satisfactory except for sinking of the temporal fossa.

Patient E. R., a 42-year-old white man, was seen with conjunctival pigmentation and a small nodule at the angle of mandible noted one year previously. An exenteration including periosteum was done. The anterior one half of the temporalis muscle was transplanted into the orbit over a 20-mm. gold sphere. The patient had a rapid and uneventful recovery except for the presence of a small hematoma temporally corresponding to the dead space left by the removal of the portion of temporalis muscle. An insufficient amount of time has elapsed since this operation to assess the cosmetic result.

Fig. 17 (Reese and Jones). Patient I. R. Photograph taken six months after surgery, showing appearance after recurrence of melanoma within the orbit.

Patient M. S., a 60-year-old man, had drooping of the left upper lid for 10 months. Biopsy specimens from the caruncle revealed carcinoma. An exenteration including periosteum and the bone of the upper inner angle of the orbit was done. Part of the temporalis was transplanted into the orbit over a gold sphere. The convalescence was uneventful.

Patient S. M., a white boy, aged six years, was referred with a history of a tumor of the right upper lid. On examination a firm mass could be felt through the upper lid nasally which seemed to be attached to the bone and could be palpated quite deeply. No exophthalmos was present and no pre-

Fig. 16 (Reese and Jones). Patient I. R. Side view of patient taken two months after surgery.

Fig. 18 (Reese and Jones). Patient H. A. Photograph taken five months after surgery. Insufficient filling of the defect is apparent.

Fig. 19 (Reese and Jones). Patient S. M., who was shown in previous paper. This photograph was taken after the second socket reconstruction and 12 months after the original surgery.

auricular nodes were felt in the neck. A complete medical workup failed to reveal a primary tumor site elsewhere in the body. It was, therefore, felt that the orbital tumor was primary and accordingly, an exenteration with a temporalis muscle transplantation was carried out. A gold sphere was not used. Tissue study of the mass revealed a rhabdomyosarcoma. One and one-half years postoperatively, the patient had a plastic repair of the contracted right socket with insertion of a stent which was made up of dental wax to conform to the socket. This stent was covered with a Thiersch graft taken from the left thigh. Two weeks later the dental stent was removed. A good fornix was present above and below and the graft appeared to be viable. It was not possible to insert a conformer, of the size available, between the lids. Thus, the eye was left open with an ointment applied to the macerated cheek. Five months after this procedure, the patient was noted to have a satisfactory result except for some sinking in the temporal region. On follow-up one year and three months after the first reconstruction of the socket, the patient was in good health. He had a good cilia line but had lost part of the upper and lower cul-de-sac. A second reconstruction of the socket was accordingly done. A split-thickness skin graft was taken with the Paget dermatome from the left side of the abdomen. The old contracted skin graft from the right socket was removed. Blunt and

Fig. 20 (Reese and Jones). Patient F. B. Photograph taken six months after surgery.

Fig. 21 (Reese and Jones). Patient F. B. Photograph taken seven months after restoration of socket with a split-thickness skin graft (approximately 23 months after exenteration procedure).

sharp dissection was carried down to a point inside the orbital rim above and below and the fissure was lengthened especially at its nasal end. The previously prepared lucite molds were found to be too large. Therefore, two large conformers were sutured together back to back and the skin graft was wrapped around these conformers on all sides. The conformers were then placed between the lids which were sutured together over the graft and the conformers. One month after this restoration procedure, the conformer was removed and the socket appeared adequate except temporally where more canthus was desirable. Two weeks later a beautiful cosmetic result was noted. Earlier photographs of this patient were shown in the previous paper. One photograph of this patient is shown taken 12 months after the original surgery (fig. 19).

Patient F. B., a 47-year-old white man, had a rupture of the right globe which subsequently proved to contain a malignant melanoma of the choroid. Accordingly, the orbit was exenterated with a temporalis muscle transplant performed in the usual manner. Approximately 17 months after this surgery, a reconstruction of the fornices with a split-thickness skin graft was carried out. Subsequent to this procedure, the lower fornix was deepened on one occasion and the lower lid was shortened. The upper fornix is still to be made deeper. Photographs are shown after the temporalis transplant and after the reconstruction of the socket with the patient wearing a prosthesis (figs. 20 and 21).

Patient D. D., a 10-year-old white boy, was seen with a tremendous exophthalmos of the right eye. Nodes were palpable in the neck. Biopsy tissue from the orbit revealed leiomyosarcoma or hemangiopericytoma. Accordingly, an exenteration and a temporalis muscle transplant were carried out. This procedure varied from the usual one in that the

conjunctiva and the full thickness of the lids were saved. Early in the convalescence, the prosthesis was fitted but the best result will only be obtained after the lower fornix has been elevated. A photograph taken before surgery (fig. 22) and one taken six months after surgery (fig. 23) are shown.

Discussion

When confronted with the necessity of an exenteration there may be five surgical courses open to the surgeon: (1) ordinary exenteration without graft; (2) exenteration with split-thickness skin graft; (3) exenteration with temporalis muscle transplant; (4) exenteration with temporalis muscle transplant and reconstruction of the socket; (5) exenteration with temporalis muscle transplant and preservation of the conjunctiva.

If there is extension to bone or if radiation is to be given, the ordinary exenteration is the procedure of choice. In our opinion it is always preferable to do the exenteration without skin graft. The final defect is smaller and the convalescence is often shorter. If it is felt that exenteration is clean, then an even better procedure is to follow the exenteration with a temporalis muscle transplant. The after-care is much reduced and the operative site is dry in one week. The cosmetic result is superior. There remains the possibility of a socket reconstruction and the wearing of a prosthesis at a later date. If the case is such that the conjunctiva can be preserved, then a prosthesis may be worn within two weeks after surgery. One such case is included in this study.

Fig. 22 (Reese and Jones). Patient D. D. Photograph taken prior to surgery, showing the enormous protrusion of the skin and conjunctiva of the right lower lid. The mass is so large it pushes the globe under the upper lid.

Fig. 23 (Reese and Jones). Patient D. D. Photograph of patient taken six months after exenteration and temporalis transplantation with preservation of the conjunctiva. Further procedures will be done to elevate the socket.

To date, only two socket reconstructions have been done at long intervals after the original temporalis transplant, but there seems to be no reason why the reconstruction of the socket cannot be done at the same time as the exenteration and temporalis muscle transplant. This technique is now being worked out.

The advantages of the technique deserve reiteration. Foremost is the superior cosmetic result. Even without the restoration of the socket, the result is more acceptable than the usual exenteration. Furthermore, the continuing refinement of the technique for restoration of the socket promises good prosthetic results. Not the least of the advantages lies in the shortened hospital stay and the greatly abbreviated convalescence.

The only major disadvantage of a temporalis muscle transplant which has been recognized to date is that it may mask a recurrence. One patient in the present series had a recurrence which was not immediately appreciated. This patient had distal as well as local recurrence of tumor, but in some cases there might be a masking of a solitary local recurrence. This is probably of theo-

TABLE 1

SUMMARY OF CASES

Case	Diagnosis	Surgery	Repair	Present Status
J. C. Previously reported	Rhabdomyosarcoma	Exenteration with temporalis muscle transplant	—	Good. To have socket restoration
S. A. New	Metastatic carcinoma	Exenteration with temporalis muscle transplant	—	Good. To have socket restoration
B. L. New	Malignant melanoma of conjunctiva	Exenteration with temporalis muscle transplant	—	Living with disease
R. H. New	Malignant melanoma of conjunctiva	Exenteration with temporalis muscle transplant	—	Good
J. F. New	Hemangiopericytoma	Exenteration with temporalis muscle transplant	—	Good. To have socket restoration
R. G. New	Hemangiopericytoma	Exenteration with temporalis muscle transplant	—	Good. To have socket restoration
B. H. New	Rhabdomyosarcoma	Exenteration with temporalis muscle transplant	—	Died of metastase 15 mo. postoperatively
K. T. New	Malignant melanoma of conjunctiva	Exenteration with temporalis muscle transplant	—	Good
L. B. New	Rhabdomyosarcoma	Exenteration with temporalis muscle transplant	—	Good. To have socket restoration
V. W. New	Rhabdomyosarcoma	Exenteration with temporalis muscle transplant	—	Good. To have socket restoration
I. R. New	Malignant melanoma of conjunctiva	Exenteration with temporalis muscle transplant	—	Died of recurrence one year after surgery
H. A. New	Orbital extension of choroidal melanoma	Exenteration with temporalis muscle transplant	—	Good
A. G. New	Orbital extension of choroidal melanoma	Exenteration with temporalis muscle transplant	—	Good
P. G. New	Malignant melanoma of conjunctiva	Exenteration with temporalis muscle transplant	—	Good
A. C. New	Malignant melanoma of conjunctiva	Exenteration with temporalis muscle transplant	—	Good
E. R. New	Malignant melanoma of conjunctiva	Exenteration with temporalis muscle transplant	—	Good
M. S. New	Carcinoma	Exenteration with temporalis muscle transplant	—	Good

TABLE 1 (*Continued*)

Case	Diagnosis	Surgery	Repair	Present Status
S. M. Previously reported	Rhabdomyosarcoma	Exenteration with temporalis muscle transplant	Restoration of socket with split skin graft	Wears prosthesis
F. B. New	Orbital extension of choroidal melanoma	Exenteration with temporalis muscle transplant	Restoration of socket with split skin graft	Wears prosthesis
D. D. New	Hemangiopericytoma	Exenteration with temporalis muscle transplant	—	Wears prosthesis

retical rather than practical importance. Minor drawbacks are temporary difficulty in jaw movement, and, in some cases, a sinking of the temple from which the muscle was transplanted.

Summary

1. The technique of orbital exenteration and repair by temporalis muscle transplant is described.

2. Twenty cases are presented.

3. The advantages and disadvantages of the technique are discussed.

4. The improved cosmetic result is illustrated.

73 East 71st Street (21).

Reference

1. Reese, A. B.: Exenteration of the orbit: With transplantation of the temporalis muscle. Am. J. Ophth., **45**:386, 1958.

EXTIRPATION OF CONJUNCTIVA, TARSI, AND LID MARGINS FOLLOWING ENUCLEATION OF THE EYE*

Howard Naquin, M.D.
Baltimore, Maryland

Eighty-eight years ago, in 1872, Streatfeild[1] proposed that, instead of the unvarying rule of preserving as much of the conjunctiva as possible following enucleation of the globe, in certain instances, the conjunctiva be totally destroyed and the lids sewn together. He recommended this procedure when the wearing of an artificial eye was impractical and could not be made practical by the arts and skills of surgery. He also recommended this procedure when the patient objected to wearing an artificial eye, either before the enucleation or at any subsequent time. Streatfeild stated "It is an improvement in appearance as well as a comfort to the patient; in any case if an artificial eye is not or cannot be worn, whether the palpebral aperture and conjunctival sac be full sized or almost closed by cicatricial contraction, it is a disgrace to surgery not to close up the ugly chiasm, and it is easily done."

Andrew,[3] in 1885, discussed this operation, and described his surgical technique. He stated "unfortunately, excision, unless aided by an artificial eye, whilst relieving one evil, frequently produces another. In rare instances, the conjunctival sac is too sensitive or puckered to admit an artificial eye; but far more common is the inability of the patient to provide a glass eye; and the imper-

* Presented at The Wilmer Residents Association meeting, April 7, 1960.

fect protection of the socket by a shade, rendering the cavity a receptacle for dirt and filth, and the want of support causing the lids to fill in, and the lashes to rub against the lining, are the means of exciting such inflammation, thickening and pain in the sac, as to irritate the eye. In such cases, for years, I have recommended, and when permitted, carried out the plan of removing the entire conjunctival sac, in addition to excision of the ball."

Green,[2] in 1882, apparently unaware of Streatfeild's article, reported before the Americal Ophthalmological Society an operation for the removal of the eyeball together with the entire conjunctival sac and lid margins. He reported four cases, all of malignant tumors involving the lids. His cases actually represented cases of partial exenteration of the orbit for malignant tumor.

Alt,[4] in 1903, reported performing this operation in seven cases. One of his cases had been reported by Green. He stated that the only reference to "Green's operation" in current treatises on surgery of the eye was in Czermak's[5] textbook, *Eye Operations*. He quotes Czermak; "In cases in which the wearing of an artificial eye is a priori impossible because the conjunctival sac is, even if only partly, shrunken, it would be best to attempt to obliterate the whole cavity and to obtain a lasting closure of the palpebral fissure. For nothing looks more disfiguring than a partially open palpebral fissure with deeply sunken eyelids showing an empty cavity. Moreover the patient is continually annoyed by the flow of tears and conjunctival secretion, the normal removal of which is prohibited by the disarrangement of the drainage apparatus." Czermak recommended splitting the lids into their two parts, tarsus and skin, and then dissecting out the retrotarsal folds and the peripheral parts of the conjunctival sac. He then enucleated the eye, and finally stitched the free borders of the lids together. He evidently did not cut off the lid margins.

Alt did not elaborate on all of his seven cases but all of those he did discuss had epitheliomas of the lids. He concluded that "the freedom from continued secretion and irritation from the unsightly empty orbital cavity and the fact that by covering the orbit new irritations and perhaps with them relapses are definitely excluded seem to make this mode of operating one which should be more frequently employed than as yet it seems to be. For most working people it would seem to be much better than the wearing of an artificial eye even after simple enucleation."

Since 1908, the only reference we have been able to find on this operation has been a brief note by Guyton[6] in 1948. He stated "Alt even advised Green's procedure of removing all conjunctiva, tarsi, and lid margins and sewing the skin of the lids together (complete ablation of the socket) as preferable for most working people on the grounds that the plain skin-covered socket did away with all socket irritation and discharge and was often less conspicuous than a socket containing a prosthesis." None of the current textbooks on surgery of the eye describe this operation.

Extirpation of conjunctiva, tarsi, and lid margins can be done at the same time as enucleation, or it can be carried out any time following enucleation. The technique of surgery may be varied to suit the surgeon and the individual case. Local anesthesia is preferable. The important surgical steps, not necessarily in order, are: Enucleate the eye, after a circumcorneal conjunctival peritomy. Undermine and dissect the remainder of the conjunctiva to the posterior tarsal margins. Incise the skin at the medial and lateral canthi, taking precaution to avoid the angular vessels nasally. Excise the entire lid margins, including skin, lashes, tarsal plates, caruncle, puncta, canaliculi, and conjunctiva. Do not remove the lacrimal gland or lacrimal sac. If desired, an appropriate inert sphere or implant may be placed in the muscle cone, and the muscles sutured anteriorly. The skin

margins are sewn together in a horizontal line, and a pressure bandage applied.

During the past seven years, enucleation followed by extirpation of conjunctiva, tarsi, and lid margins, with suturing of the skin of the lids, has been carried out in more than a dozen cases at the Wilmer Institute and at the Fort Howard Veterans Administration Hospital. Records of 12 cases are available for this report. All of the patients were males, and their ages ranged from 50 to 97 years.

In four patients, enucleation had been carried out some time prior to ablation of the socket, while in eight, enucleation and ablation of the socket were carried out at the same procedure. In the four patients with previous enucleation, the eyes had been removed 50 years, 10 years, eight years and six years respectively, and no prosthetic eye was ever worn. Brief clinical summaries of six cases are included. All 12 of the operations were done under local anesthesia. A number of the operations were done by the resident staff and there were no operative or postoperative complications. In every instance the patient has been entirely happy with the postoperative cosmetic result, and none has regreted the choice of operation. The four patients who had had enucleation done previously all expressed regret that the operation had not been carried out sooner. Some patients have worn dark or tinted glasses postoperatively. Others have used a black eye shield, and others have used no masking devices. We have seen no complications from leaving the lacrimal gland in situ.

The indications that have been used for choosing this operation are shown in Table 1. In the first case, conjunctiva obtained from an ablated socket was used to repair a cicatricial entropion and trichiasis of the opposite eye prior to a corneal transplant. The patient expressed so much satisfaction with his ablated socket, that it prompted further use of the operation.

Another patient, a 97-year-old white man with a blind painful eye, was not burdened during his last years with the bother and annoyance of having to put up with a useless conjunctival socket. Another patient was a 59-year-old white man with generalized neurofibromatosis, a chair-ridden resident of a state chronic disease hospital. Enucleation was necessary but the lid abnormalities precluded the wearing of a prosthetic eye. Ablation of the socket eliminated the annoyance of a useless moist and irritable conjunctival socket.

TABLE 1

INDICATIONS FOR EXTIRPATION OF CONJUNCTIVA, TARSI, AND LID MARGINS, FOLLOWING ENUCLEATION OF THE EYE.

I.	Donor source for conjunctival transplant
II.	Inability to wear artificial eye
	A. General reasons
	1. Age
	2. Serious illnesses
	3. Mental disability
	4. Financial
	B. Ocular reasons
	1. Contracted socket
	2. Lid abnormalities
III.	Cosmetic
	If the patient prefers no artificial eye

In another patient, several unsuccessful plastic operations for repair of a contracted socket had been attempted over an eight-year period. Ablation of the socket put an end, once and for all, to the patient's problem, and he is quite happy wearing a "Hathaway shirt" type eyepatch.

In patients with contracted sockets or lid abnormalities that prevent the wearing of an artificial eye, careful thought must be given as to whether it would be best to attempt to correct the ocular abnormality surgically in order to enable the patient to wear an artificial eye, or to give up on this possibility and to ablate the socket. Age, sex, occupation, mental and physical health must all be taken into consideration.

In one patient whose mental status made the wearing of an artificial eye impossible, ablation of the socket has eliminated the annoyance of a useless conjunctival socket and has simplified nursing care.

In six patients ablation of the socket was

carried out because the patient did not want to fuss or bother with an artificial eye. Three of these had demonstrated their conviction by not obtaining an artificial eye for 50, 10, and six years following enucleation. In three patients, enucleation and ablation of the socket were carried out simultaneously after discussing the advantages and disadvantages with the patient. None have regretted their decision but, since ablation of the socket cannot be undone, it should not be performed unless both surgeon and patient are convinced it will best serve the patient's needs.

Case reports

Case 1

Fifteen years previously, C. C., a 67-year-old white man (J. H. H. #645761), was burned in both eyes by alkali. Ten years previously the right eye was enucleated, and an optical iridectomy was done on the left eye. No prosthesis had ever been worn. Examination showed operative anophthalmos on the right, with scarring of the lids and conjunctiva and chronic conjunctivitis. The left eye had vision limited to hand movements at one foot. There was a cicatricial entropion of the left upper lid with trichiasis, and a dense leukoma of the cornea. In preparation for a keratoplasty in the left eye, on July 15, 1953, conjunctiva was transplanted from the right socket and the trichiasis was relieved. All remaining conjunctiva on the right was removed, the tarsi and lid margins excised and the lid margins sutured. Two months later, partial penetrating keratoplasty was performed in the left eye. The patient expressed great satisfaction with the absence of conjunctival irritation and discharge from the right socket. He regretted that this procedure had not been carried out 10 years previously.

Case 2

N. W., a white man aged 59 years (J. H. H. #659747), had generalized neurofibromatosis and was admitted for removal of a blind, painful right eye. Surgical removal of neurofibroma of the right upper lid had been attempted 38, 31, 20, and 19 years before, each time followed by recurrence of the tumor. Examination showed generalized neurofibromatosis with a large deforming mass involving the right upper lid. The right eye was phthisical, with no light perception. On December 16, 1953, enucleation of the right eye, with excision of all conjunctiva, tarsi, and lid margins was carried out and the lids were sewn together. The wearing of a prosthetic eye in this case was obviously impossible, even if the patient had so desired.

Case 3

Fifty years before, the left eye of J. M., now aged 97 years (J. H. H. #712775), was struck by a rock and vision markedly impaired. For many years the eye was blind and for several years had been intermittently painful with excessive conjunctival discharge. Examination showed the right eye to be normal and the left eye to be phthisical. On August 9, 1955, enucleation of the left eye with ablation of the socket was done. The age and general medical status of this patient made the wearing of a prosthetic eye absurb.

Case 4

Fifty years previously, the right eye of E. McC., a 72-year-old white man (J. H. H. #681538), was enucleated following a firecracker explosion. He never obtained an artificial eye. He sought attention for recurrent sebaceous cysts of the right lower lid. Examination showed a normal left eye. The right socket was chronically inflamed, and there were several large sebaceous cysts of the right lower lid. On August 13, 1954, extirpation of conjunctiva, tarsi, lid margins, and sebaceous cysts was carried out. This patient simply did not want to wear a prosthetic eye. Ablation of the socket was carried out 50 years too late.

Case 5

Six months previously the right eye of A. M., a 50-year-old Negro, sustained a corneoscleral laceration. This was repaired, but the eye became completely blind and painful. After discussion, the patient elected to have the lids sewn together. On November 20, 1959, enucleation of the right eye with extirpation of conjunctiva, tarsi, and lid margins was carried out.

Case 6

The left eye of F. S., a 62-year-old Negro, was blind following an injury many years ago. There were recurrent episodes of conjunctivitis in both eyes and recurrent pain in the left eye. Examination showed the right eye to be normal. There was bilateral conjunctivitis. The left eye was blind and phthisical. Enucleation was advised. The patient objected to wearing a prosthetic eye, and therefore on September 18, 1959, enucleation, with excision of conjunctiva, tarsi, and lid margins was done.

Summary

Extirpation of conjunctiva, tarsi, and lid margins following enucleation of the globe is an old operation that has fallen into disuse. It is not an operation to replace simple enucleation or evisceration of the globe. Nevertheless, it is an operation that should be familiar to all ophthalmic surgeons, and when the indications are present, it has proven to be a useful and gratifying procedure. Surgical indications, operative technique, and cosmetic results in a small series of patients have been presented.

The Johns Hopkins Hospital (5).

References

1. Streatfeild, J. E.: On the preservation or destruction of the conjunctiva in cases of extirpation of the globe. Lancet, 1872, pp. 821, 855.
2. Green, J.: An operation for the removal of the eyeball together with the entire conjunctival sac and the lid margins. Am. J. Ophth., **1**:65, 1884.
3. Andrew, E.: Enucleation of the eyeball with obliteration of the conjunctival sac. Brit. M. J., December 19, 1885, p. 1155.
4. Alt, A.: Removal of the eyeball together with the tarsi, conjunctival sac and lid margins. Am. J. Ophth., **20**:69, 1903.
5. Czermak, W.: Eye Operations. Berlin, Urban & Schwarzenberg, 1908.
6. Guyton, J. S.: Enucleation and allied procedures: A review and description of a new operation. Tr. Am. Ophth. Soc., **46**:472, 1948.

MACULAR AND EXTRAMACULAR SEROUS CHORIORETINOPATHY*

With remarks upon the role of an extrabulbar mechanism in its pathogenesis

Bertha A. Klien, M.D.
Chicago, Illinois

Occurrence of extramacular serous chorioretinopathy is possibly more common than the understandable scarcity of complaints from this condition leads one to believe. An old extramacular lesion of this type, which to judge from its histologic appearance had preceded the macular lesion for some time, was reported before (Klien[1]).

As in the macular variety, two phenomena may accompany it which may raise the question of an intraocular tumor, namely irritative proliferation of the pigment epithelium producing elevated pigmented lesions or a circumscribed retinal detachment with a tendency to persist unaltered for a long time.

The mounds of proliferated pigment epithelium gradually lose their pigment content and thus become more distinguishable from pigmented tumors, but the persistent circumscribed retinal detachments will continue to feed suspicion of a new growth unless repeated slitlamp studies of the fundus prove its absence beyond doubt. The persistence of such localized retinal detachments in an apparently noninflammatory condition is an interesting, as yet unexplained phenomenon.

The following clinical and histopathologic study of three eyes, one with a recent central serous chorioretinopathy and an extramacular lesion of the same type, simulating a choroidal tumor clinically, thus leading to enucleation of this eye, the other two previously reported but re-examined for this study, may shed some light upon the pathogenesis of this condition and at the same time direct attention to the possibility of having old and fresh lesions of a similar, noninflammatory and nonmalignant nature coexist in one eye.

Case reports

Case 1*

R. W., a man 50 years of age, had noted blurring of his left vision associated with frequent left-sided frontal headaches for the past four or five weeks prior to his first examination. Corrected vision was: R.E., 20/25; L.E., 20/70. The external ocular findings in both eyes and the right fundus were normal. Tension of both eyes was 12.0 mm. Hg (Schiøtz).

Examination of left fundus. The optic disc was normal. Just temporal to the disc and extending downward there was a flat, slate-gray, pigmented lesion with indistict borders and a somewhat striate overall pattern. Measurable elevation of this area

* From the Department of Surgery, Section of Ophthalmology, The University of Chicago. This work was supported in part by grant B-1589 of the National Institute of Neurological Diseases and Blindness and the L. B. and E. M. Kuppenheimer Fund.

* For the clinical data on this patient I am indebted to Dr. David Shoch.

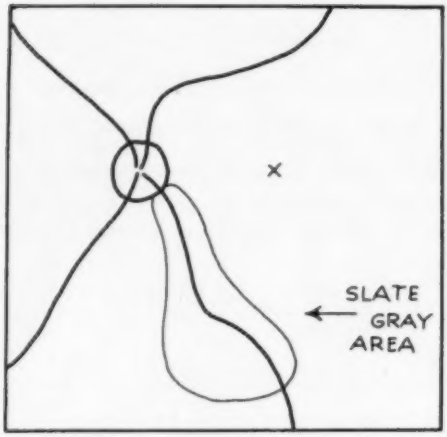

Fig. 1 (Klien). Sketch of fundus lesion in Case 1. Circumscribed extramacular serous retinal detachment.

was about one diopter. No hemorrhages or exudates were visible. Study of the lesion with contact lens and slitlamp did not give any additional information.

There was a tonguelike defect in the left visual field which corresponded almost exactly to the lesion in size and position (figs. 1 and 2). In addition, a relative central scotoma of two or three degrees could be demonstrated at one meter with a six-mm. red test object.

The eye was removed because a malignant melanoma of the choroid was suspected. General physical examination, including an electrocardiogram and skull X-ray films, was noninformative.

Histopathologic findings. The eye was embedded in celloidin and sectioned serially. The only pathologic finding in the anterior segment was a dilatation of the long posterior ciliary arteries and their ramifications and of the veins and capillaries throughout the ciliary body. Many of these vessels contained aggregations of varying sizes of leukocytes, among which eosinophiles were unusually numerous, similar to the more obvious findings to be described in the choroidal and orbital veins. The stroma of iris and ciliary body contained a few scattered lymphocytes and plasma cells and some large cells with granular cystoplasm of the appearance of mast cells but no inflammatory foci.

The most striking pathologic finding in the posterior segment was a circumscribed low retinal detachment between the optic papilla and the macula (figs. 3 and 4) which corresponded to the gray lesion noted clinically. Within the region of the detachment and immediately adjacent to it the first retinal neuron was destroyed and replaced by glial plaques which contained proliferated and migrated pigment epithelial cells. The continuity of the pigment epithelium was preserved but its cells were somewhat irregular in size and pigment content. The detachment became flatter toward the nasal side but extended to the edge of the optic nerve. There was no evidence of an inflammatory process within or around the region of the detachment in choroid or sclera.

A similar, circumscribed retinal detachment but much smaller and of more recent origin was found in the temporal equatorial region. Another more recent well-defined retinal detachment, which had apparently started with a detachment of the pigment epithelium, occupied the macular region (fig. 5). The retina was otherwise well preserved. Noteworthy was the fullness of the retinal arteries and veins which was particularly obvious in the optic papilla. Aggregations of leukocytes, among them many polymorphs and eosinophiles, were also contained within the retinal vessels and were interpreted as evidence of stasis. The optic nerve was normal.

Throughout the eye, congestion of the choroidal veins and capillaries was prominent despite the marked shrinkage by fixation of the choroid, and became especially obvious near the vortex veins (figs. 6 and 7). Large and small conglomerations of white blood cells many of them polymorphs and eosinophiles, were attached to the walls of the veins or suspended within the blood column, seemingly plugging some of the smaller lumens. Venous dilatation was so marked that broad channels connected all sizes of lumens down to the capillary level (see also fig. 12 in Case 2 and fig. 16 in Case 3).

No disease of the sclera could be found which might have been held responsible for the congestion of the vortex veins in this eye with normal intra-

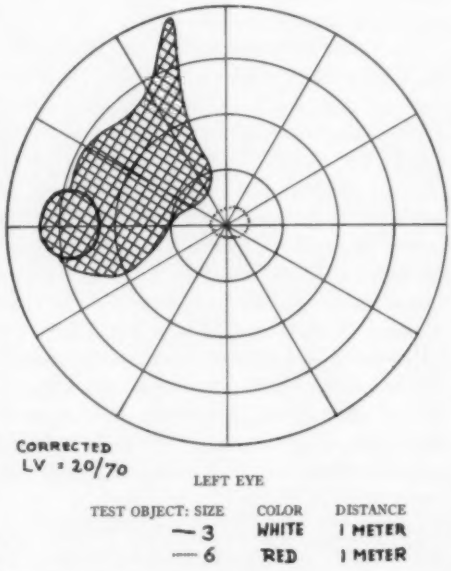

Fig. 2 (Klien). Central visual field, left eye, Case 1.

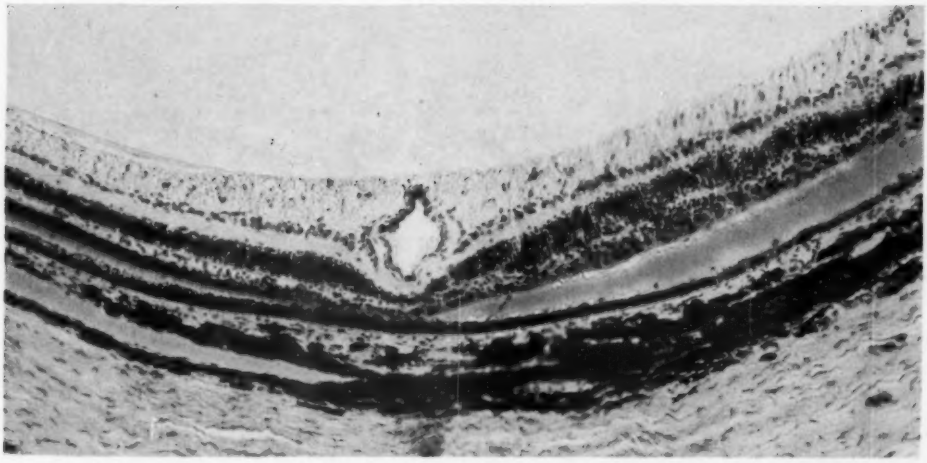

Fig. 3 (Klien). Temporal edge of circumscribed retinal detachment in Case 1. (×120.)

ocular pressure, but inspection of the retrobulbar regions revealed changes in arteries as well as veins indicative of widespread orbital stasis of both vascular systems, but especially the veins (figs. 8, 9, 10, and 11). Many small veins seemed entirely plugged by aggregations of leukocytes, a finding particularly striking because of the complete lack of inflammation in the surrounding tissue.

The findings in this case, which pointed to an extrabulbar mechanism in the production of uveal stasis and serous subretinal transudation led to re-examination of two eyes with recent serous chorioretinopathy previously discussed, and to the surprising discovery that all of them had certain orbital and uveal vascular changes in common.

Cases previously published (Am. J. Ophth., **36**: 5, 10, 1953): Only those findings which were encountered in sections made additionally since the original publication or those whose importance was not realized at the time will be discussed.

CASE 2

Re-evaluation of Case 2 (Case 3 in previous publication, page 5) revealed marked dilatation of veins and capillaries in anterior and posterior uvea despite formalin fixation over many days and marked uveal shrinkage. Also in this eye, broad channels

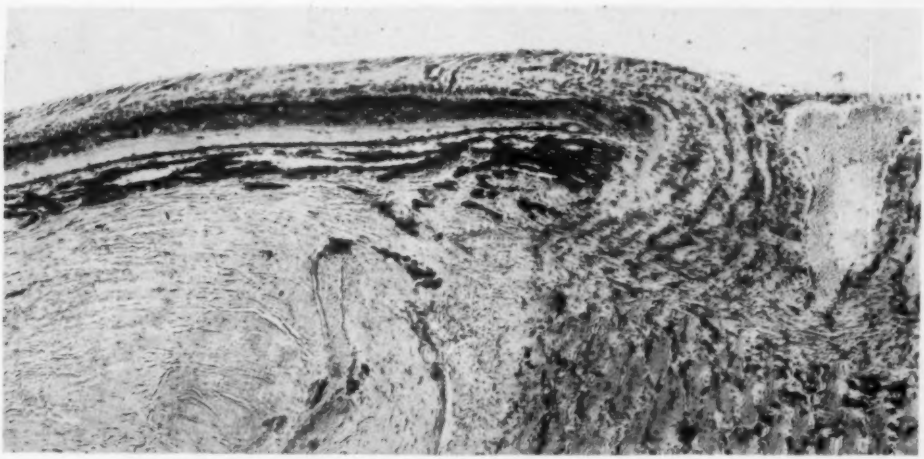

Fig. 4 (Klien). Nasal edge of circumscribed retinal detachment in Case 1. Note venous congestion in optic nerve. (×65.)

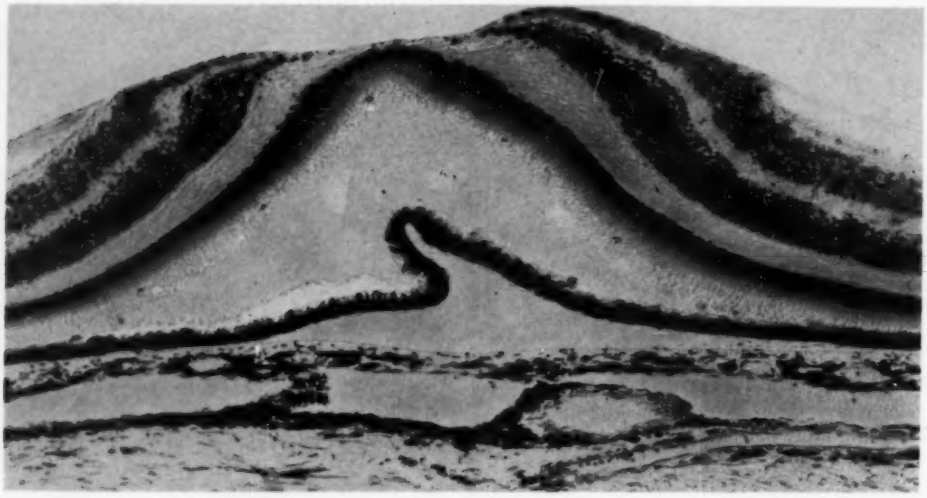

Fig. 5 (Klien). Macular lesion in Case 1. Circumscribed detachment of pigment epithelium and retina. (×120.)

connecting the large veins and capillaries directly in many places (fig. 12) suggested that this congestion had existed for some time. Also in this specimen aggregates of leukocytes, many of them eosinophiles, were seen within the veins and some of the arteries, not only in the choroid but to a very striking degree also in the retrobulbar vessels (fig. 13). Signs of inflammatory disease were completely absent in choroid and retrobulbar tissues, suggesting stasis as the most probable explanation for these vascular findings. Subretinal transudation had been minimal in this eye in contrast to Cases 1 and 3, leading mainly to reactive proliferation of the pigment epithelium, which was prominent in the subacute macular lesion and an old extramacular lesion described in detail before. Retinal arteries and veins were remarkably full also in this eye and there was one small retinal hemorrhage in the paramacular region.

Case 3

Case 3 (Case 4 in previous publication, page 10) showed the evidence of uveal congestion and stasis to a more pronounced degree since the eye was not fixed in formalin (figs. 14, 15, and 16). Also in this eye intravascular eosinophilia was marked and plugging of retrobulbar venules by conglomerations of white cells was in evidence (fig. 17). There was

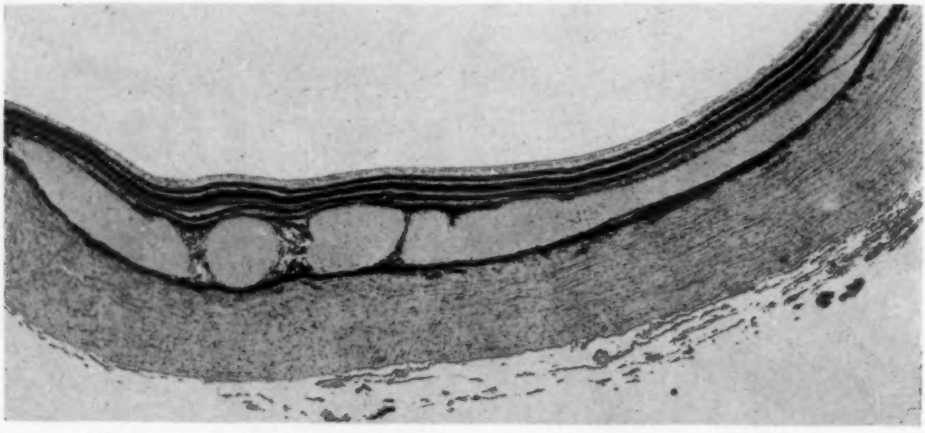

Fig. 6 (Klien). Dilated choroidal veins in Case 1, containing aggregates of leukocytes, many of them eosinophiles. (×30.)

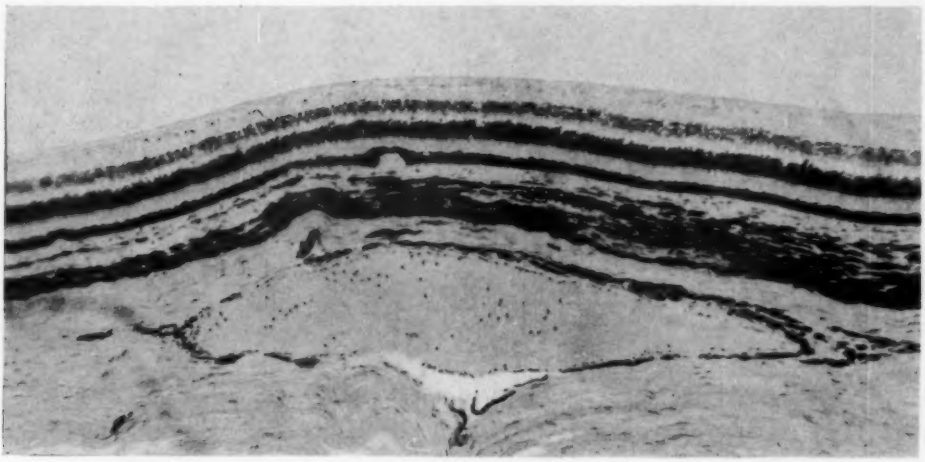

Fig. 7 (Klien). Dilated vortex vein, intrascleral course, in Case 1, containing numerous leukocytes, many of them eosinophiles. (×120.)

complete absence of inflammatory changes. Toluidin blue revealed an increase in the number of mast cells in certain regions of the choroid and in the anterior uvea (fig. 18).

The macular lesion in this case consisted of a circumscribed retinal detachment similar to the macular and extramacular lesions in Case 1.

Comment

Few instances of persistent circumscribed retinal detachments without tear in the region of the posterior pole are recorded in the literature.

Phillips[2] discusses two interesting cases of this type, both having occurred in myopes; one in a man 38 years of age, with a myopia of −17.0 D. sph. ⌒ −1.0 D. cyl. ax. 60°, the other in a 52-year-old woman with a myopia of −20 D. sph. In only one of these eyes was there also a posterior detachment of the vit-

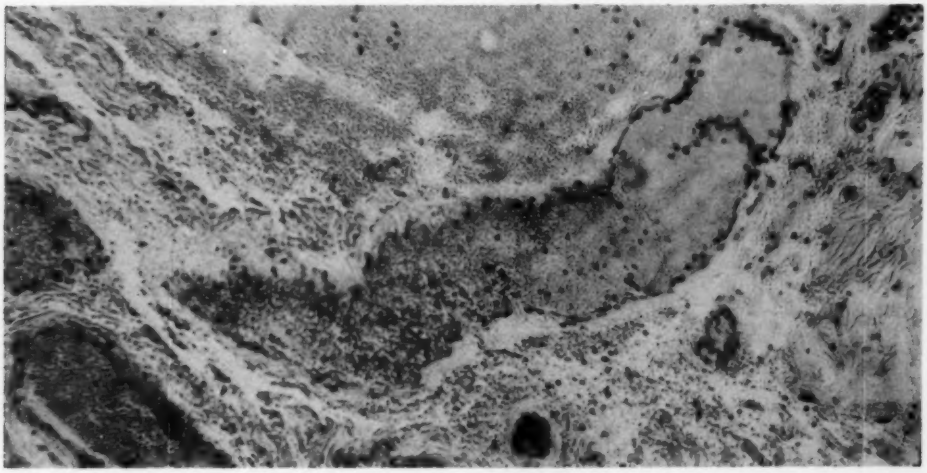

Fig. 8. (Klien). Congested orbital vein in Case 1 containing many eosinophiles and some venules, plugged completely by leukocytes. (×175.)

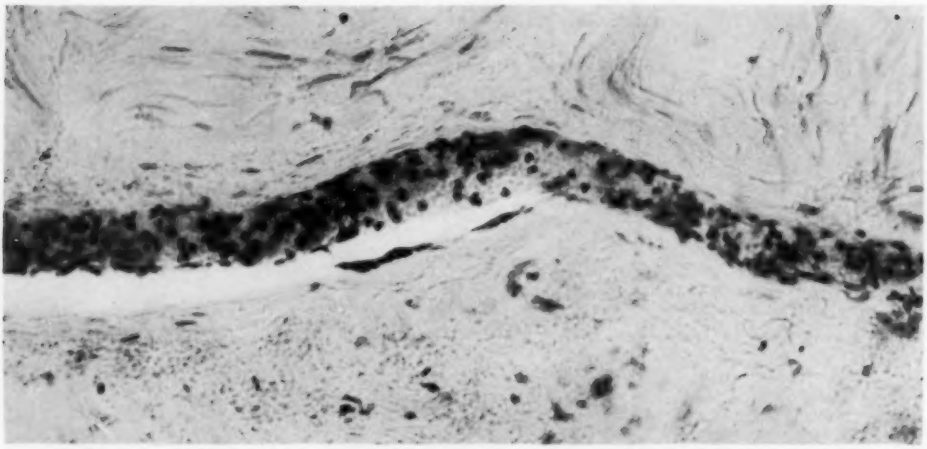

Fig. 9 (Klien). Orbital vein in Case 1 in area remote from that shown in Figure 8, containing dense aggregates of leukocytes. Note lack of inflammation in surrounding tissues, suggesting stasis as cause of vascular lesion. (×315.)

reous. In his opinion these detachments were caused by myopic degeneration of choroid and retina "which must alter the ability of the two main retinal layers to adhere together." More specifically, that would have to mean irritation of the choriocapillaris, preceded perhaps by some damage to Bruch's membrane which can produce a variety of myopic changes such as "lacquer cracks," the Fuchs' spot, and so forth. Some of these are characterized in the early stages by the subjective symptom of metamorphopsia indicating some subretinal transudation. More pronounced extravasation from the choriocapillaris might lead a step further to an actual circumscribed retinal detachment in this region.

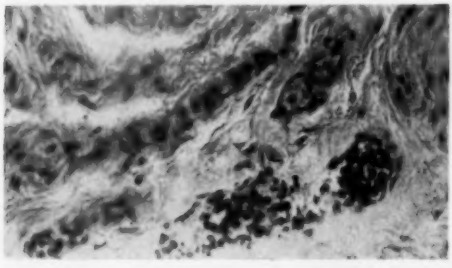

Fig. 10 (Klien). Orbital veins in Case 1 in region remote from areas shown in Figures 8 and 9, containing plugs of leukocytes, many of them eosinophiles. (×315.)

No myopia existed in the three cases herein discussed. They had, however, certain subjective and objective findings in common. In two of them the ocular disease was preceded, respectively accompanied, by severe frontal headaches, in one of them of the migrainous type. In all three eyes there was a striking dilatation of the vortex veins with indications of stagnation within their entire bed, a finding whose possible implications had not been previously realized.

In this connection the experimental work of Sachsenweger and Lukoff[8] may be significant. These authors studied the effects of closure of one or more of the vortex veins of dogs by ligation or coagulation. While slow closure of a vortex vein is unimportant, sudden closure of one or two vortex veins produces hyperemia of choroid, ciliary body and iris in their own fields of distribution and often also in the fields of the intact veins. Closure of three produces in addition to the uveal congestion, also circumscribed, flat or moundlike detachments of the retina by transudate. Only sudden closure of all four vortex veins produces intrachoroidal and

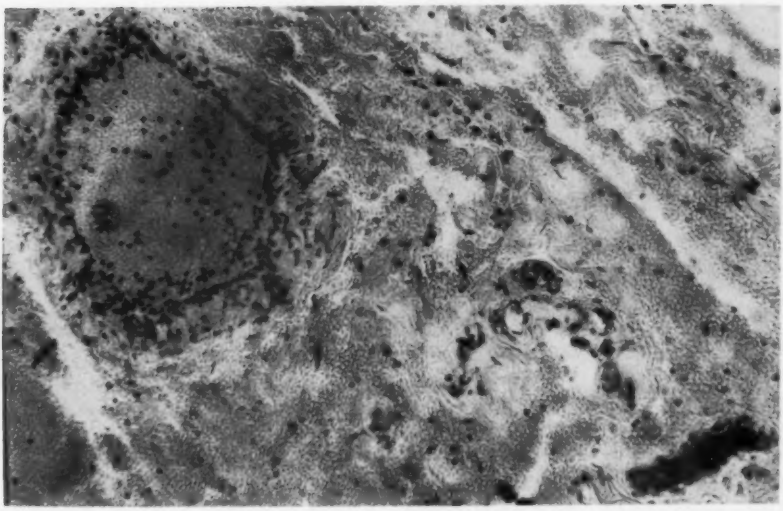

Fig. 11 (Klien). Orbital lumen of nasal long posterior ciliary artery in Case 1, just before entrance into sclera, congested and containing numerous eosinophiles. (×175.)

subretinal hemorrhages and increased intraocular pressure.

Could the co-existence of circumscribed serous retinal detachments or detachments of the pigment epithelium and tremendous stagnation in the bed of the vortex and orbital veins in the three eyes discussed above point to some common etiologic factor?

The complaint of headaches just prior to the onset of the ocular condition which was recorded in two of the patients and which is not an uncommon complaint in this disorder, might be an indication of a sudden hemodynamic intracranial disturbance, leading to

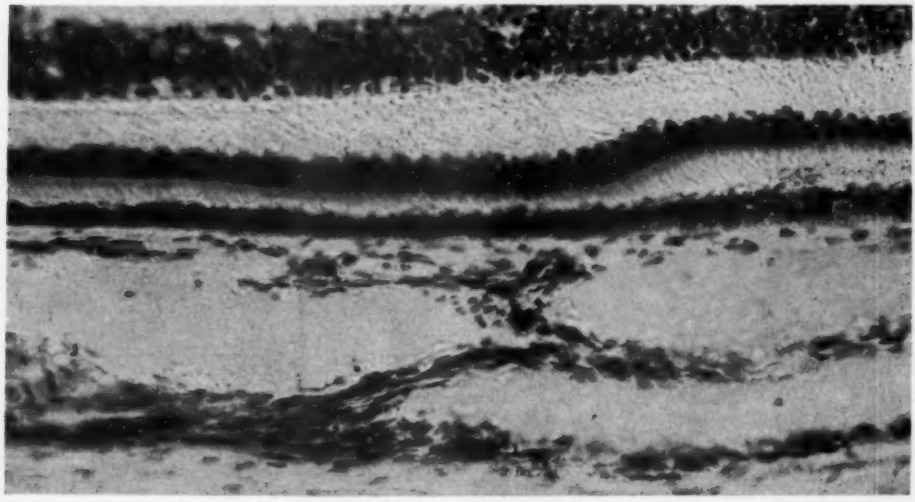

Fig. 12 (Klien). Congestion of choroidal veins and capillaries in Case 2, aggregates of leukocytes, many of them eosinophiles in venous lumens. (×315.)

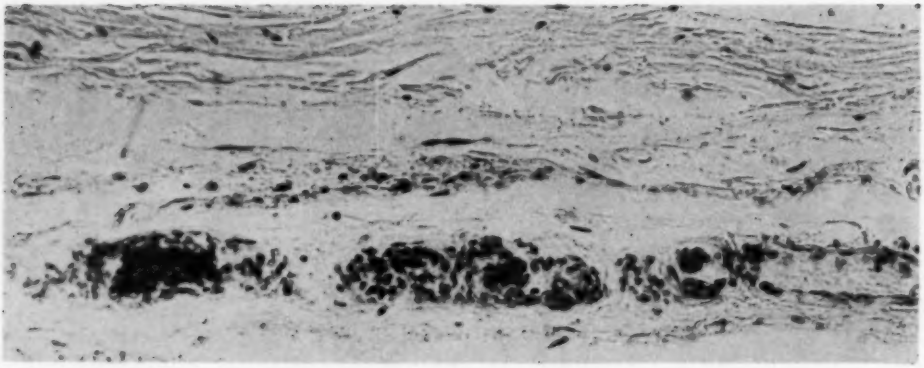

Fig. 13 (Klien). Orbital veins in Case 2, congestion and plugging with leukocytes, many of them eosinophiles, of lumens. Note absence of inflammatory signs in adjacent tissues. (×315.)

temporary stasis of the orbital and vortex veins via the cavernous sinus. Interdependence of the intracranial, orbital and retinal venous pressures is well known from the more dramatic instances of sudden increase of the intracranial pressure in skull traumas. It is now well recognized that sudden increase of intracranial pressure may result in increase of venous pressure in the orbit and retina, thus producing independently orbital and subhyaloid hemorrhages. Lesser degrees of stasis could lead to lesser consequences; increase of orbital venous pressure not to the point of rupture of small vessels but merely to the point of stasis could produce stagnation in some of the vortex veins duplicating the conditions of Sachsenweger's experiments. The fact that also the posterior ciliary arteries and the retinal arterial and venous trees appeared very full and congested in the three eyes examined histologically is indicative of a rather widespread hemodynamic disturbance in extrabulbar regions.

Maumenee[4] in his recent discussion of a series of serous and hemorrhagic macular detachments, some of them in eyes obtained at autopsy, made some interesting and pertinent observations without following them up further. He remarked upon the high incidence of intracranial lesions, such as hemorrhage, brain abscess and meningitis, in this material which "suggests that a disturbance in the cerebral circulation is a factor in the production of serous detachment of the macula." Discussing the etiology of the hemorrhagic type with special reference to a possible neurovascular pathogenesis, he further states that the histologic picture is "more

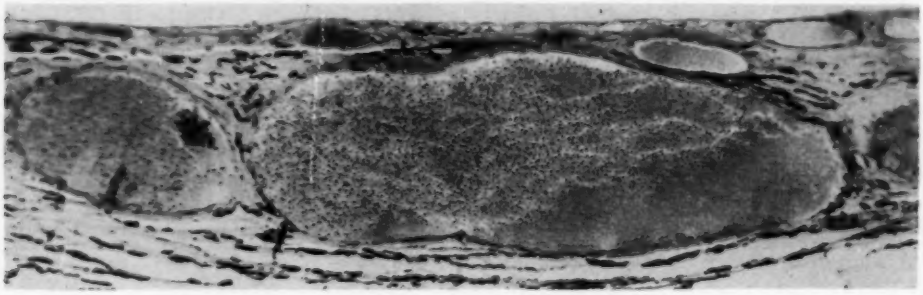

Fig. 14 (Klien). Congestion and stasis in choroidal veins in Case 3. Lumens contain many aggregates of leukocytes, numerous eosinophiles among them. (×100.)

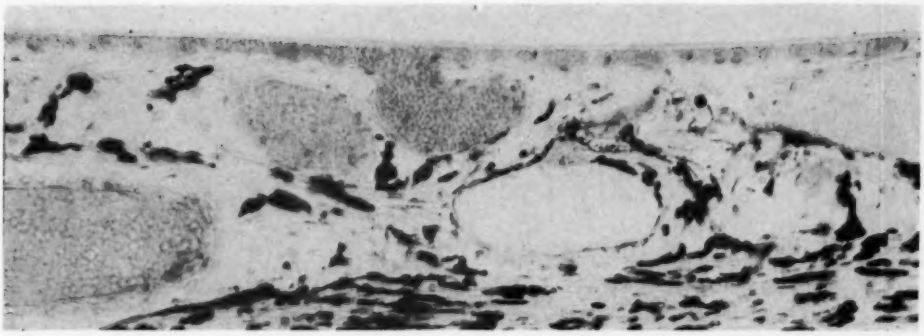

Fig. 15 (Klien). Dilatation of choroidal capillaries in Case 3. Note congested transition from capillary into venule. (×210.)

suggestive of a venous blockage" than of a cessation of the arterial circulation.

Both of these observations suggest that at least in part of his material he was dealing with cases similar to mine.

Headaches are frequently mentioned in the literature as being associated with serous chorioretinopathy, although different authors attach varying degrees of importance to this phenomenon. Cordes[5] gives perhaps the most detailed description of this type of headache. It is most often unilateral on the side of the ocular lesion, parietal, frontal or orbital in location, and often associated with retrobulbar pain. One of Cordes' patients vividly describes it as different from any headache he had ever had as a "sort of dead and warm feeling." At any rate, a careful history concerning headaches should be taken in patients with this condition since this symptom may be more important as a guide to therapy than heretofore realized.

Certain subjective and objective findings which the three cases discussed here had in common and some of which are met with frequently in similar clinical material suggest the possibility of defining a subgroup of the serous and probably also the hemorrhagic chorioretinopathies. Most investigators have expressed the view that there are probably no basic differences between the two and that their pathogenesis, whatever it is, must be related. Clinically, this group might include all cases with severe headache, which either precedes the visual disturbance by a short period or develops simultaneously with it, or which may be of the migrainous type and may have existed for some time before the onset of the ocular disease. Varied allergies are commonly encountered in patients with the latter type who eventually develop a chorioretinopathy. Also a psychosomatic element appears to be prominent in many cases of this group.

Ophthalmoscopically, the fundus lesions are characterized by circumscribed macular or extramacular detachments of retina or pigment epithelium due to serous or hemorrhagic extravasations.

Histologically, three eyes of this type showed tremendous dilatation and stasis with intravascular eosinophilia in the beds of the orbital and vortex veins and their tributaries, and marked fullness of the posterior ciliary arteries and the retinal vascular trees pointing to an extensive extrabulbar hemodynamic disturbance associated with the ocular disease.

For comparison, two other histopathologic specimens were reviewed, one an eye with a central serous retinopathy of toxic origin (Klien[6]), the other an eye with a serous detachment of the pigment epithelium but otherwise completely normal, which was obtained in the course of an exenteration of the orbit for a squamous cell carcinoma.

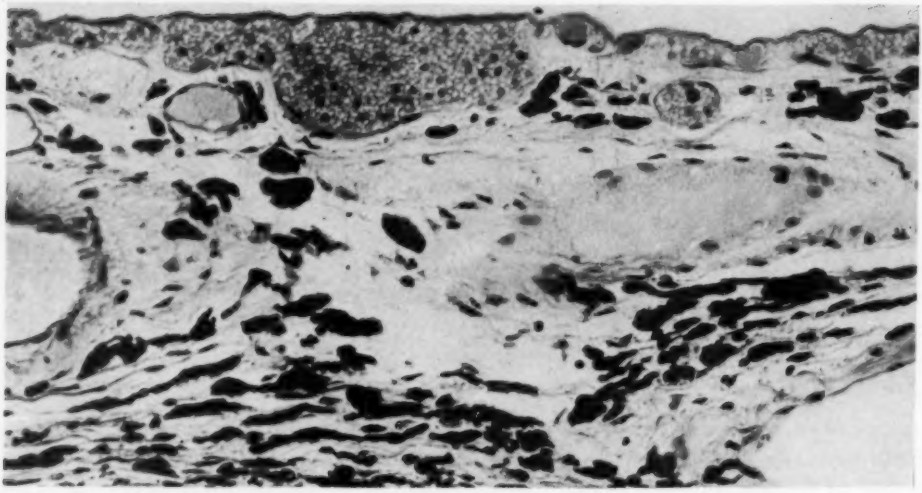

Fig. 16 (Klien). Diffuse dilatation of capillaries in Case 3. Lumens contain many eosinophiles. Note lack of inflammatory changes in choroid. (×315.)

In the former, no sign of choroidal participation could be detected and there were no choroidal or orbital vascular alterations. This illustrates well the view also held by Mitsui and Sakanaski,[7] and by Duggan,[8] that central serous retinopathy may exist alone without choroidal participation and should be differentiated from the combined form; some of the differential diagnostic points have been discussed in an earlier publication (Klien[1]).

The second eye, on the other hand, showed marked venous and capillary congestion and stasis in the choroid, the pars plana of the ciliary body, and the orbit. The latter was found not only in regions adjacent to the tumor but also in more remote areas, indicating a general impairment of orbital venous circulation which was apparently transmitted to the uveal veins, thus leading to the serous detachment of the pigment epithelium. The retinal arterial and venous trees and the posterior ciliary arteries were very full also in this eye but there was no eosinophilia.

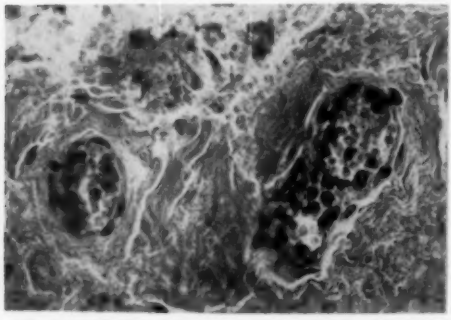

Fig. 17 (Klien). Orbital venules in Case 3. Lumens congested, containing aggregates of leukocytes. (×500.)

The superficial resemblance of some of the histologic features found in the choroids of the three eyes described above to spongiosis chorioideae as discussed by Pau[9] invites a brief comment upon the latter.

Amotio chorioideae, more correctly termed spongiosis choroideae by Pau, since it actually is not a detachment but an edematous imbibition of the choroid, is not a disease sui generis but a secondary phenomenon arising from a disturbance of the vasoregulatory mechanism in the uveal vasculature which accompanies a variety of ocular conditions. Occurring after surgical procedures it is usually characterized by a flat anterior chamber; experimentally produced by injuries of the posterior vitreous, or complicating inflamma-

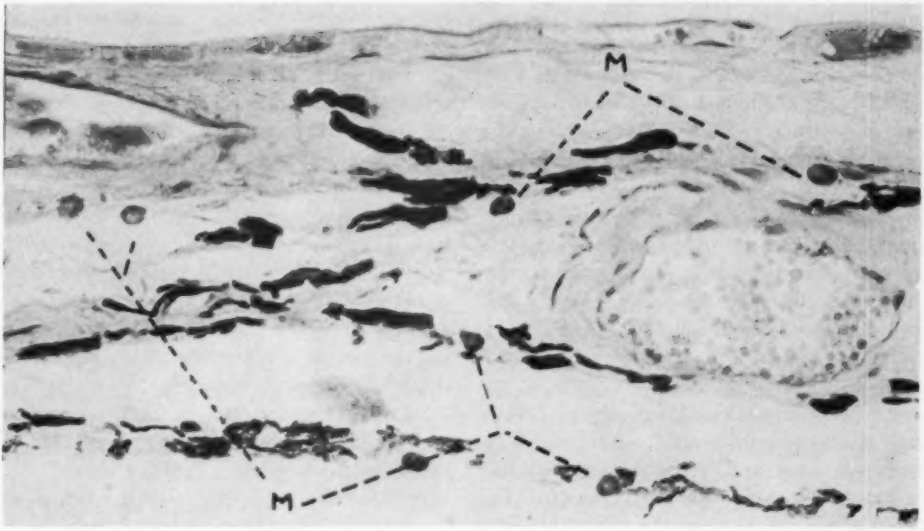

Fig. 18 (Klien). Increased number of mast cells (M) in the choroid in Case 3. (Toluidin blue, ×420.)

tory processes such as episcleritis or scleritis or less obvious ocular disease, it is usually associated with acute hypotony and often extreme depth of the anterior chamber. The electrolyte disturbances which seem to be responsible for its morphologic features have been discussed in detail by Pau.

A striking dilatation of the vortex and larger choroidal veins is also part of the picture of spongiosis chorioideae. The smaller veins and capillaries, however, appear collapsed as if pressed free of blood by the increased pressure of the edematous tissue; this finding is in great contrast to the extreme fullness of these vessels which could be demonstrated in the three eyes with serous chorioretinopathy. The extravasations in the latter condition do not seem to be as much the result of increased permeability due to a disturbed vasomotor equilibrium such as produces amotio chorioideae but rather due to an increased venous and capillary pressure similar to the condition created by Sachsenweger and Lukoff's experiments.

Perhaps routine measurements of orbital resistance with Copper's exophthalmometer and search for minute degrees of unilateral exophthalmos in patients with acute serous chorioretinopathy might yield some information concerning absence or presence of an increased orbital venous pressure in such cases.

Several therapeutic approaches could be tried in cases where an extrabulbar hemodynamic disturbance is suspected. In cases of acute or subacute serous or hemorrhagic chorioretinopathy ergot preparations, by reducing the blood volume in the posterior ciliary arteries, may prove to be as beneficial as they are in migraine. Saliva-soluble sublingual tablets of ergotamine tartrate (Ergomar*), two mg. each, have recently appeared on the market and achieve their purpose more rapidly and with fewer side-effects than oral preparations (Martin, Feldman, and Cutler[10]). Dosages similar to those found effective in migraine might be given, such as one or two sublingual tablets 15 minutes apart, up to four tablets within an hour.

In fresh, as well as older, cases desludging agents may prove useful. The chloroquine compounds have been tried with suc-

* Nordsen Pharmaceutical Laboratories, Inc., Irvington, New Jersey.

cess by Braley and Hamilton,[11], Eggers,[12] and others. Employed for their antiparasitic properties in those cases of chorioretinopathy which were thought to be possibly due to invasion of ocular structures by Entamoeba histolytica, their therapeutic success could be due to some of their nonspecific effects of increasing the velocity of peripheral circulation and of having desludging properties in general, thus decreasing embolic and thrombotic phenomena as has been recently discussed by Madow.[13]

Summary and Conclusions

1. The clinical and histopathologic findings in an eye with central serous chorioretinopathy associated with two extramacular lesions of the same type were discussed. The thought, if it occurs to the examiner, of a possible coexistence in one eye of residues from an old and a recent vascular damage of this type may uncover differential diagnostic signs such as changes in the refractive error or positive relative scotomas, which otherwise might escape attention.

2. In this eye and two others eyes with recent serous chorioretinopathy, which were discussed in a previous publication and which were re-examined for this study by means of additional sections and special stains, there was striking evidence of increased venous pressure and stasis in the vortex veins and their beds. No scleral disease or other pathologic condition directly affecting the vortex veins could be found, but the orbital veins, many of which had fortunately remained attached to these globes, were as strikingly affected as the uveal veins, suggesting that stasis may have been transmitted to the vortex veins from the orbit or possibly the intracranial cavity. Very full posterior ciliary arteries and retinal arterial and venous trees in all three eyes rounded out the picture of a widespread hemodynamic disturbance.

Marked eosinophilia in the arterial and venous blood columns, also present in all three eyes, pointed to an allergic element.

3. The interdependence of the intraocular, intraorbital and intracranial venous pressures is pointed out as a possible lead for investigation of the pathogenesis of at least a certain type of serous chorioretinopathy.

4. Therapeutic approaches suggested by this concept of an extrabulbar mechanism underlying its pathogenesis include ergot preparations, perhaps in the form of rapid acting saliva-soluble sublingual tablets, and desludging agents such as the chloroquine compounds, which also serve to increase the velocity of peripheral circulation.

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References

1. Klien, B.: Macular lesions of vascular origin: II. Functional vascular conditions leading to damage of the macula lutea. Am. J. Ophth., **36**:1, 1953.
2. Phillips, C. J.: Retinal detachment at the posterior pole. Brit. J. Ophth., **42**:749, 1958.
3. Sachsenweger, R., and Lukoff, L.: Tierexperimentelle Untersuchungen über die Folgen eines operativen Verschlusses der Vortex Venen. Klin. Monatsbl. f. Augenh., **134**:364, 1959.
4. Maumenee, A. E.: Serous and hemorrhagic disciform detachment of the macula. Pacific Coast Oto-Ophth. Soc., 1959, p. 139.
5. Cordes, F.: A type of foveo-macular retinitis observed in the U. S. Navy. Am. J. Ophth., **27**:801, 1944.
6. Klien, B.: Retinal lesions associated with uveal disease. Am. J. Ophth., **42**:843 (case 11) 1956.
7. Mitsui, Y., and Sakanashi, R.: Central angiospastic retinopathy. Am. J. Ophth., **41**:105, 1956.
8. Duggan, W. F.: Chorioidosis centralis serosa. Arch. Ophth., **27**:123, 1942.
9. Pau, H.: Ueber die Amotio chorioideae (spongiosis chorioideae). Klin. Monatsbl. f. Augenh., **130**: 347, 1957.
10. Martin, B. J., Feldman, H. S., and Cutler, M.: The use of saliva-soluble, sublingual form of ergotamine in migraine. EENT Digest, May, 1960, p. 15.
11. Braley, A. E., and Hamilton, H. E.: Central serous choroidosis associated with amebiasis. AMA Arch. Ophth., **58**:1, 1957.
12. Eggers, H.: Extraintestinal amebiasis involving the macula. New York State J. Med., Dec. 1, 1959, pp. 4435-4436.
13. Madow, B. P.: Use of antimalarial drugs as "desludging" agents in vascular disease processes. J.A.M.A., **172**:1630, 1960.

APPEARANCE AND DISAPPEARANCE OF THE FUNDUS DISTURBANCE IN OGUCHI'S DISEASE*

TIKASI SATO, M.D.
Yokohama, Japan

AND

KENICHI BABA, M.D.
Tokyo, Japan

Oguchi's disease is a kind of night blindness which was discovered by Chuta Oguchi[1,2] in 1907, and which is found almost exclusively in Japan. About 120 cases of the disease were reported in Japan and Formosa by 1953, but only about 10 cases have been reported in other countries. In the United States, Klien[3] reported a case in 1939, which was the first in that country. Wilder[4] reported the progress of the same case after 14 years.

Oguchi's disease is recessive hereditary; therefore, in most cases, the parents are found to be consanguine. The disease starts in infancy and is nonprogressive. The fundus is peculiar and, while the optic disc is normal, the retina resembles something whose gilt is coming off, the veins showing distinctly in relief. This description may be typically Japanese and hard to understand, but Wilder[4] has described it as "deep to the vessels is a mottled, yellowish, phosphorescent discoloration of the retina."

A further peculiarity of the disease is that the fundus disturbance disappears and the fundus becomes normal during dark adaptation (Mizuo's[5] phenomenon).

When Sato attended the XVII International Ophthalmological Congress in 1954, he talked in various places on diseases named after Japanese doctors, such as Harada's disease, Masuda's disease, Oguchi's disease, and so forth, and learned that Oguchi's disease was most interesting to foreign doctors. Sato was asked to take color pictures of the fundus of the eyes before and after Mizuo's phenomenon.

Recently, two brothers and a sister afflicted with Oguchi's disease (a boy, aged 17 years, a girl aged 12 years, and a boy aged 11 years, whose parents are cousins) were examined. Another girl, aged four years and similarly afflicted (whose parents are also cousins and who has two normal sisters, aged nine and six years), was also examined.

None of the relatives of these four children seem to be night-blind. All four parents had noticed that these children were night blind from their infancy. Except for the night blindness and retinal disorders, all four children are entirely healthy, and their vision, color vision, and visual fields are normal.

An attempt was made (Baba) to take pictures of the fundi of the children, using Noyori's fundus camera. However, the peculiar condition of the fundi, resembling something whose gilt is coming off, did not show clearly. The retinas looked as if they had become partly normal after Mizuo's phenomenon.

At first it was thought that the fault lay in the exposure of the film, and different exposures and various films (Fuji color film, Sakura color film, Kodak Ektachrome) were experimented with. A Zeiss fundus camera was also tried, but the results were all more or less unsatisfactory.

Figures 1 and 2 picture the fundus before and after dark adaptation. In Figure 1, the condition of the fundus resembling something whose gilt is coming off shows a little, though not very plainly. In Figure 2, Mizuo's phenomenon has taken place in the same

* This research was done at the Sato Ophthalmologic Clinic, Yokohama, under Tikasi Sato, M.D., University of Tokyo School of Medicine, assisted by Kenichi Baba, M.D., Juntendo Medical School.

places, and the peculiar condition has disappeared. The actual phenomenon is far more remarkable than it appears in these pictures.

When a fundus afflicted with Oguchi's disease is examined in the usual way, the condition resembling something whose gilt is coming off, can be seen remarkably well. (Figure 3 is a sketch of a fundus afflicted with the disease.) In a color picture, however, the peculiar condition is not very plain, as in Figure 1, where it looks as if the fundus disturbance of Oguchi's disease had half disappeared during Mizuo's phenomenon and the fundus had become almost normal, though other parts of the retina are clearly seen.

Why is it that the peculiar disturbance of the fundus in Oguchi's disease does not come out clearly in a picture of the fundus? Sato thought perhaps it was because the principle of the fundus camera was different from the method of fundus examination. Therefore, he experimented by using many filters and by changing the intensity of the light.

Then he noticed that the angles between the incident rays and emergent rays differed in the fundus camera and in fundus examination. In the usual fundus examination, the directions of the two rays are practically the same, and the angle is almost zero degrees, whereas, in the fundus camera, the two rays are made to maintain certain angles, in order to prevent corneal reflex.

Sato thought, therefore, that perhaps this difference caused the fundus to appear almost normal in the picture. Using a slitlamp microscope and a Hruby lens, he turned the rays from the side on a fundus afflicted with Oguchi's disease, and, to his great surprise, the fundus disturbance peculiar to the disease practically disappeared. Then, when he shifted the light so that the rays fell on the eye straight from the front, the fundus disturbance suddenly reappeared.

Thus it was discovered that the fundus disturbance in Oguchi's disease could be made to appear and disappear repeatedly by shifting the direction of the rays. It was like changing the color lighting in a theater.

It was surmised, therefore, that pictures of fundi afflicted with Oguchi's disease were not clear because of the angle between the incident and emergent rays. The remarkable changes in the fundi caused by the angle between the rays were seen in all four cases reported herein. The phenomenon was also verified at Tokyo University and at Tokyo Medical and Dental University, and so far no experiments have disapproved it.

We examined pictures of afflicted fundi taken at Nagoya University and also at Tokyo Medical College and found that, in all the pictures, the fundi looked as if Mizuo's phenomenon had already started. Consequently, the phenomenon of the appearance of Oguchi's disease when the angle of the incident and emergent rays approaches zero, and of its disappearance when the angles of the two rays increase, seems to be fairly well established.

The fundus disturbance, however, does not actually disappear completely. We examined the fundi with a Zeiss slitlamp microscope, enlarging the pupils to the utmost, in order that the incident and emergent rays might make a certain angle. It was discovered that, when the two rays formed an angle of 15 degrees, the fundi disturbance of the Oguchi's disease disappeared, disappearance varying from one fourth to three fourths in different areas. These figures represent only a rough estimation and may not be exact. In general, the disturbance was least likely to disappear from areas where it had originally been most dense.

References on the phenomenon were next examined. Shinobu Ishihara[6] had examined a fundus afflicted with Oguchi's disease in the rays of the evening sun, using indirect ophthalmoscopy, and had discovered that the part of the fundus which lay in the shadow looked as if seen through a veil.

Hisatake Yamamoto[7] had discovered that a fundus afflicted with Oguchi's disease lost a little of its golden glow, and a slight tinge of red was added when the mirror was re-

Figures 1 and 2 (Sato and Baba). Appearance and disappearance of fundus disturbance in Oguchi's disease.

Fig. 1. Reproduction of color film of a fundus afflicted with Oguchi's disease before dark adaptation. (Right eye of an eight-year-old boy.)

Fig. 2. Reproduction of a color film of a fundus afflicted with Oguchi's disease after dark adaptation (practically the same place as seen in Figure 1). It has become normal after Mizuo's phenomenon.

moved a little from the examiner's eye in direct and indirect ophthalmoscopy.

When Sato checked the experiments of Ishihara and Yamamoto, he recognized a slight change in the condition of the fundus which seemed to correspond to the phenomenon seen in pictures of such fundi or by the slitlamp microscope. However, the degree of change by the methods of Ishihara and Yamamoto was much smaller than in fundi examined with a slitlamp microscope. Undoubtedly this was why the phenomenon had attracted little notice, though it had been reported 45 years ago.

In order to see whether the phenomenon could be seen under different conditions, we changed the directions of the rays in the ophthalmoscope.

In a young normal eye, the retinal reflection is very clear. It decreases slightly when rays are applied obliquely. But this phenomenon is not so remarkable in normal eyes as in eyes afflicted with Oguchi's disease. Moreover, the reflection in the normal eye spreads out like a cloud; in Oguchi's disease the disturbance resembles a collection of small grains. In normal eyes the reflection shifts noticeably to the opposite direction, that is, to the left when the light came from the right, and to the right when the light came from the left; only a slight shift is noticeable in Oguchi's disease. A reflection resembling gold sand is sometimes found around the normal macula of a young person; however, no such remarkable change is seen as in Oguchi's disease.

We also examined abnormal eyes, those afflicted with retinitis pigmentosa, retinitis punctata albescens, and choroidal atrophy, but no appearance and disappearance of the fundus disturbance as in Oguchi's disease could be detected. Since the fundus of an eye afflicted with Oguchi's disease resembles the tapetum of the fundus of a dog, we examined the eyes of a dog under barbital narcosis with a slitlamp microscope; neither the phenomenon in question nor Mizuo's phenomenon was seen.

Fig. 3 (Sato and Baba). A sketch of a fundus afflicted with Oguchi's disease before dark adaptation. (From Ishihara's *Textbook of Ophthalmology.*)

From these results, it may be concluded that the phenomenon of the appearance and disappearance of the fundus disturbance caused by the size of the angles between the incident and emergent rays is peculiar to Oguchi's disease, since it cannot be seen in normal eyes nor in eyes afflicted with other diseases, nor in the tapetum of a dog.

Sato, inquiring into the causes of the phenomenon, assumed that, since it is a momentary phenomenon, it cannot be a chemical change; it must be a physical change. What physical change is it? The reflected polarized ray is remarkably intense when an incident ray meets the surface perpendicularly and straight upon it.

Dr. Mishima* was asked to examine the fundus of an eye afflicted with Oguchi's disease with a polarized light filter; no similar phenomenon occurred. It may be concluded, then, that the phenomenon in question is not caused by polarization. Other causes that may be considered are that the refractive index is as high as in diamonds (though this seems very unlikely), or that the construction and distribution of the pigment grains of the retina may be peculiar. These discoveries may be of some use in interpreting the nature of the substance of the retina in which Mizuo's phenomenon takes place.

* From the Department of Ophthalmology, Tokyo Medical and Dental University.

Conclusion

1. We have tried to take pictures of the fundi in four cases of Oguchi's disease.

2. The pictures of the fundi did not show satisfactorily the disturbance peculiar to Oguchi's disease, while other parts of the retina came out clearly.

3. The fundus disturbance peculiar to Oguchi's disease appears and disappears momentarily, as the angles between the incident and emergent rays are made smaller or larger, in examination of the fundi with a slitlamp microscope and Hruby's lens. This phenomenon may be the reason why pictures of such fundi do not come out clearly.

4. The phenomenon has been observed in the eyes of the four cases of Oguchi's disease, as well as in other cases treated at university hospitals, but has not yet been found in a normal eye, or an eye afflicted with other diseases, or in a dog's tapetum.

5. The phenomenon is a physical one not caused by polarization light. It seems improbable that it is caused by a high refractive index. A probable cause may be found in the peculiar structure and distribution of the pigment grains of the retina.

6. The phenomenon described herein may serve as a key to interpret the nature of the cause of Mizuo's phenomenon.

Onoecho 6-90.

References

1. Oguchi, Ch.: Upon a new night blindness. Acta Ophth. Jap., **11**:123-134, 1907.
2. ———: Ueber die eigenartige Hemeralopie mit diffuser weissgraulicher Verfärbung des Augenhintergrundes. Arch. f. Ophth., **81**:109-117, 1912.
3. Klien, B. A.: A case of so-called Oguchi's disease in the U.S.A. Am. J. Ophth., **22**:953-955, 1939.
4. Wilder, H.: Oguchi's disease. Am. J. Ophth., **36**:718-719, 1953.
5. Mizuo, G.: On a new discovery in the dark-adaptation on Oguchi's disease. Acta Ophth. Jap., **17**: 1148-1150, 1913.
6. Ishihara, S.: On the cause of Oguchi's disease. Acta Ophth. Jap., **19**:705-712, 1915.
7. Yamamoto, H.: Clinical study of Oguchi's disease. Acta. Ophth. Jap., **39**:1089-1106, 1935.

THE TECHNIQUE AND ORGANIZATION OF MASS SCREENING FOR GLAUCOMA*

W. Leydhecker, M.D.
Bonn, Germany

Four years ago I did the first mass screening for glaucoma in Europe in which 10,000 subjects were examined. The incidence of simple glaucoma (including two patients with pigmentary glaucoma) after the age of 40 years was 2.3 percent and corresponded closely to the frequency which was found in the United States. Further results have been published.[1-5]

This paper deals with the organization of a mass screening program. Since I found no literature on the subject, a report on our experience might also prove helpful to those who intend a mass screening for diseases other than glaucoma.

*From the University Eye Clinic. Director: Prof. Dr. H. K. Müller.

Two stages of screening

It seemed best to screen in two stages. At the first, the quickest method should be used for the preliminary separation of suspects from nonsuspects and it should be carried out at the working place of the individual. At the second stage, only preliminary suspects are invited to the clinic where time and facilities are available for an exact diagnosis and for the final separation into three groups: glaucoma, suspects, nonsuspects.

For the first stage (preliminary separa-

tion), tonometry with a standardized Schiøtz tonometer is the best method. It is not necessary and takes too much time to include at this stage tests for visual acuity or for field defects. None of the patients finally classified as having glaucoma had a decreased visual acuity which was caused by glaucoma, and many of them had no field defects. On the other hand, all glaucoma patients with field defects or with cupping of the optic nervehead had an increased intraocular pressure. I have shown[4] that it takes, on the average, over 10 years for a slight ocular hypertension to cause field defects. Therefore, tonometry is the quickest and safest method for making a preliminary separation during mass screening. The limit which we used was a tension of 3.5/5.5 gm. or more. All these people were regarded as preliminary suspects and were invited for a thorough examination in the clinic.

The examination represented the second stage of screening. It included: slitlamp examination, gonioscopy, funduscopy, visual acuity, perimetry, tonometry, and tonography. Some patients were hospitalized, tension was measured at different hours of the day and night over several days, and provocative tests were performed.

Facilities for preliminary screening

Our screening was performed in factories and in large offices. No medical rooms were available. These existed but their situation was not central enough, or else they were too small. We had, therefore, to plan carefully everything that would be needed during the screening.

There should be one bright room for tonometry with as many tonometry beds as doctors working, one chair for each bed so that the doctor can sit behind the patient's head, one table at the side of each chair for tonometers, cotton wool, note books, and so forth, one bin for used swabs, and about five chairs for waiting patients. There must be a second room with sufficient chairs for about 20 patients who will be anesthetized by a nurse before entering the examination room.

This equipment should be inspected on the day before the screening by the doctor in charge. It seems strange, perhaps, to describe such details but in practice it will be seen that a faulty organization in any minor detail causes considerable trouble, and that the patients will blame the doctor rather than their office or factory administration if, for instance, sufficient chairs are not there. At one place I had no time for this inspection and took the word of a nonophthalmologic colleague to whom I had outlined all my wishes. I found there, instead of a tonometry bed, a stretcher for the patients, which was only a few inches above the floor and with which I had to start, since patients were already streaming in. It took hours to get a van to bring a more suitable bed, and it took days for my back to recover from the gymnastics.

Attention must be paid to good illumination so that the tonometer can be read exactly. White covers should be provided for the place where the patient's head is to rest. Fresh sheets of typing paper should be at hand for this purpose for each patient.

It should also be settled beforehand where the examiners can lunch. In some factories the canteen was not open to us and the nearest restaurant was rather far away. Notices indicating "to the eye examination" and giving the examination times and the closing time for lunch should be provided.

Arrangement of subjects to be examined

Although the privacy for patient and doctor is necessary in practice, in mass screening this proved unsuitable. If each new subject enters the room alone without knowing the procedure, the doctor not only has to explain it each time anew but has to calm the subject and, after tonometry, often has to answer his questions. This slows down the proceedings. I found it more practical for some subjects to be in the examination room to see for themselves how everything was done; how

the patient is positioned on the tonometry bed; how he stretches out his arm and looks at his thumb. Also, those waiting could see that there was no pain.

It is true that this system lacks the atmosphere of the private consultation room, but it has to be accepted as the only way to screen many patients in a short time. A personal contact with each of 10,000 subjects is scarcely possible. The dignity of a medical procedure, however, can be preserved quite well.

Instruments

The doctor himself should provide the following equipment: his professional white coat, note book and pencil, ether or alcohol for cleaning the tonometer, an alcohol burner with sufficient alcohol supply for flaming the tonometer footplate, cotton wool, corneal anesthetics in several droppers (at least one for the nurse and one for each doctor), with sufficient supply for the refilling.

There should be two tonometers for each examiner. The footplate is mechanically cleaned with an alcohol (or ether) swab after each use and then flamed for about five seconds. It is then laid aside for cooling and the second tonometer is used. After five tonometries, the instrument is disassembled and plunger and cylinder are wiped with alcohol in order to prevent friction which will arise from the capillary attraction of tears. In addition, two tonometers should be kept in reserve in case an instrument fails to work properly.

It must be understood that there usually is not one free minute once the screening has started. Ample supplies must, therefore, be provided beforehand. A shortage of cotton wool, anesthetics, alcohol, or indeed even losing a pencil, sometimes meant a serious complication under our working conditions. Although only a few kilometers away from the clinic, we felt like a desert expedition when we compared the screening conditions with those of the customary clinic with its trained staff.

Staff

It should be insured before the screening starts that each doctor is well experienced in tonometry on patients who are being tested for the first time in their lives. He must observe that the patient relaxes, that he is not holding his breath, that the gaze is exactly upward, and that the eye is steady. He must hold the tonometer for a few seconds just above the eye before resting it on the cornea and avoid a sudden approach. He must have a soft touch and a calming behavior. When the patient uses his thumb for a fixation point, it must be remembered to move the arm according to which eye is measured.

The nurse must be instructed how to apply the anesthetic without touching the eye lashes with the dropper, how to warn the patient that the first drop stings a little, and how to get the patient on the tonometry bed as soon as anesthesia is completed.

Once more, in reading this advice, it seems that self-evident details are stated. However, had I considered them before instead of regarding them as a matter of course, much trouble would have been saved. Some of our patients disappeared after the first drop and warned others to stay away on account of the "painful stinging drops which must be wrong." On one day, the nurse did not know that anesthesia lasts only for about 10 minutes and made the patient wait longer than that after the application of the drops, so that tonometry was attempted on an insufficiently anesthetized eye by an over-keen examiner. A corneal erosion resulted, which can, in a government official, be a tragedy for the doctor.

Risks

The risk of a corneal erosion should always be considered. It is especially great in neurasthenics. We learned to avoid it after a few such mishaps by strictly eliminating any subject who would not remain quiet. Some instruction cards pinned at different places in the waiting room proved most helpful. They read:

"Before the examination you get a drop put into each eye 3 times to make it insensible. You should lie down on the tonometry bed 2-7 minutes afterwards. Don't wait longer. For measuring, keep your eye very steady. Do not rub it afterwards with your handkerchief, you might scratch it without feeling anything. If you have any eye disease or a red eye, stay away and consult your doctor."

This latter point was an attempt to exclude persons with infection. Considerable costs could arise by spreading an infection, of which the patient might not even be aware. A special danger seems to be the epidemic keratoconjunctivitis.

Fortunately we spread no infection. Perhaps this was prevented by flaming the tonometer foot and plunger. However, there were approximately 10 erosions and, in one patient, a corneal foreign body which might have flown in during anesthesia after tonometry. Some of these patients consulted private doctors and tried to obtain the costs for this treatment from us.

An insurance, covering all such risks, should include accidents to the doctors on their way to and from the factory, infections of the doctors themselves or damage to their clothing when visiting the factory. An epidemic conjunctivitis in a factory, with decrease of production, can mean a law suit for a very considerable sum. I had no insurance but many sleepless nights instead.

Costs

Funds will be required for the work of doctors and nurse, for their transport to and from the factory, for lunch, for all materials, and for the insurance. Further costs will arise if patients are asked to have a more detailed examination. Even if this is offered free of charge in the clinic, workmen will not turn up, if they are not compensated for their traveling expenses and their loss of working time. Without this clinical examination the whole screening is worthless. I had no such funds and used my own car for much of the necessary transportation.

A third item is the loss of working time and hence the decrease of production which is caused by the screening itself. Each workman loses 15 to 30 minutes (for the way from his working place to the examination room, anesthesia, waiting, tonometry, way back). This was why some factories refused our offer of screening, which we did free of charge. The difficulty was overcome when we co-operated with the routine X-ray screening of the chest which is organized by industry together with public health departments. The staff of the X-ray units did not like our investigations at first because they were afraid of losing time themselves. However, we overcame this fear by performing tonometry after the X-ray examination.

Co-operation with local authorities

A mass screening must be discussed beforehand with the director of the factory or office. It is wise to contact these people via the medical adviser of the factory. If both consent, time and place must be arranged with them and contacts must be made with the man in charge of the required rooms.

The next step is giving the information to the workmen about the screening and its aims. This must be planned with the managing director. We did this by circulating the following notice:

"Approximately one among 50 adults suffer from an eye disease called glaucoma. In most cases you don't notice any signs of it at the beginning. It may affect your vision later. If it is recognized early, the disease can be stopped. A short medical examination is offered to you free of charge to make sure that you don't have this disease. No check for glasses or any other eye diseases can be done on this day. If you have any eye trouble, consult your doctor. If you have no trouble, come for a check-up at . . . (place, time)."

Then a time table must be made so that a continuous flow to the tonometry department at a rate of 20 to 25 persons/hour/doctor is obtained without complete interruption of

work at any place in the factory. This is evidently a matter for the foremen of the departments whose co-operation must be organized by a higher ranking factory official. If three doctors are working, 10 subjects should arrive every 10 minutes.

It is useful to consider first who should be consulted. Even people whose help is not required can obstruct the whole screening if they feel themselves overlooked. Some modest and kind words beforehand can be most helpful.

Co-operation with local ophthalmologists

Enthusiasm of local ophthalmologists about a mass screening can scarcely be expected. Objections will be less if the colleagues are asked for their consent before any detailed plans are set up. It should be made clear both to colleagues and subjects that anyone who is under treatment is excluded from the screening. Even so, some will come for whom glasses have recently been ordered without a tonometry having been performed and in whom glaucoma will be discovered at the mass screening. Others may come who are being treated with miotics but with the glaucoma insufficiently controlled. In all these cases much tact and diplomacy are required by the screener. In spite of every good will, however, applause can not be expected from all colleagues.

First controls

If hypertension was noted, the tonometry was repeated by a second observer with a second Schiøtz tonometer in order to exclude any technical errors. Rigidity was then estimated by using the 10-gm. weight.

Clinical examination

Arrangements for a careful examination in the clinic must be planned beforehand. A complete examination without provocative tests but including tonography last two to two and one-half hours in my hands. One should organize the tremendous amount of work which is necessary in order to examine the suspects carefully so that no waiting time for the patient is necessary, fixing date and hour exactly in the appointment book and on a card given to the patient. We used this text:

"Today we have noted an increased tension of your eyes. This means suspicion of glaucoma. The full diagnosis however can not be made by one such measurement. Please come for a complete examination to (place and exact time follow)."

The clinical examination should be done by those who did the mass screening. It is impossible to heap all this work upon the shoulders of local doctors. Besides, their standards of examination will differ, so that any scientific evaluation of the mass screening becomes impossible. Any patient confirmed as glaucomatous should, after this clinical examination, be referred to the doctor of his choice, with a letter detailing the findings.

The participation of 40 to 70 percent of the personnel of a factory can be expected. There will be approximately 30 primary suspects among each 1,000 subjects over 40 years of age. The first clinical examination of these 30 suspects will take 70 hours. Additional hours will be needed for repeated tests of fields or tension in some patients in whom the diagnosis is not clear after the first clinical examination. Then comes the irksome work to find out in each individual case which miotics are most appropriate for the normalization of tension and how often they have to be applied. I am satisfied that a treatment is sufficient only if at least 12 tension readings at different times of the day and at least four hours after the last application of miotics all show a tension of less than 4/5.5 gm.

Altogether the necessary time for the clinical work after the mass screening will amount to at least 100 hours per 1,000 subjects who were screened at the factory. This is a low estimate and does not include surgery or scientific evaluations.

My criteria for classification as normal or suspect or glaucoma have been described[4] and are beyond the scope of this paper.

Summary

Experiences in the technique and organization of mass screening for glaucoma in 10,000 subjects are detailed. It is thought that they may also be useful for screening examinations other than for glaucoma. For the first stage of screening done in factories or in offices, tonometry is recommended. Any individual with a tension of more than 20 mm. Hg (4/5.5 gm.) is invited for a complete clinical examination, which represents the second stage of screening. A diagnosis was made only after this stage. Simple glaucoma was diagnosed in 2.3 percent of adults over 40 years of age.

University Eye Clinic.

References

1. Leydhecker, W., Akiyama, K., Meinke, C., Neumann, H. G., and Schafhausen, G.: Klin. Monatsbl. f. Augenh., **132**:855-860, 1958.
2. Leydhecker, W., Akiyama, K., and Neumann, H. G.: Klin. Monatsbl. f. Augenh., **133**:662-670, 1958.
3. ———: Klin. Monatsbl. f. Augenh., **135**:188-196, 1959.
4. ———: Documenta Ophth., **13**:359-380, 1959.
5. ———: Klin. Monatsbl. f. Augenh., **135**:669-678, 1959.

GLAUCOMA IN THE CENTRAL AND SOUTH PACIFIC

William John Holmes, M.D.
Honolulu, Hawaii

Reports and surveys from various parts of the Central and South Pacific areas indicate that primary glaucoma is rare among the Polynesians, Micronesians, Indonesians, Melanesians, New Guinea tribesmen and Australian aboriginals (fig. 1).

In the Polynesian Triangle, eye surveys have been made in Hawaii, American and Western Samoa, Niue Island, Tahiti, and New Zealand.

Hawaii. For a five-year period, between 1949 to 1954, 3,867 patients were admitted to the ophthalmologic services of three of Honolulu's largest private hospitals. Of these, primary glaucoma was diagnosed in 179.

In 1955, Cowan[18] reported that glaucoma was rarely seen in private practice.

In 1957, on the basis of records of the Bureau of Sight Conservation and Work with the Blind, a report was made on the causes of blindness.[56] Among 1,677 blind persons, glaucoma was diagnosed in 103, corresponding to six percent.

Since 1957, in an attempt to study the prevalence of glaucoma in Hawaii, I have conducted a glaucoma detection survey in my private practice. All patients, 40 years of age or over in whom glaucoma had not been previously diagnosed, were subjected to tonometry, ophthalmoscopy, visual acuity and visual field measurements, and when indicated to provocative glaucoma tests (fig. 2).

Out of 2,000 examinations, glaucoma was diagnosed in 23 private patients, corresponding to 1.15 percent. The racial distribution was as follows: Caucasian 11, Chinese five, Japanese four, Filipino two, other (Korean, Samoan, Negro) one. This figure is substantially lower than those obtained from glaucoma surveys in the United States and the British Isles.

A survey such as this does not properly reflect the ethnic distribution of glaucoma in Hawaii because the background of the patients examined was not in proportion to that of Hawaii's multiracial population.

Future studies of the frequency of glau-

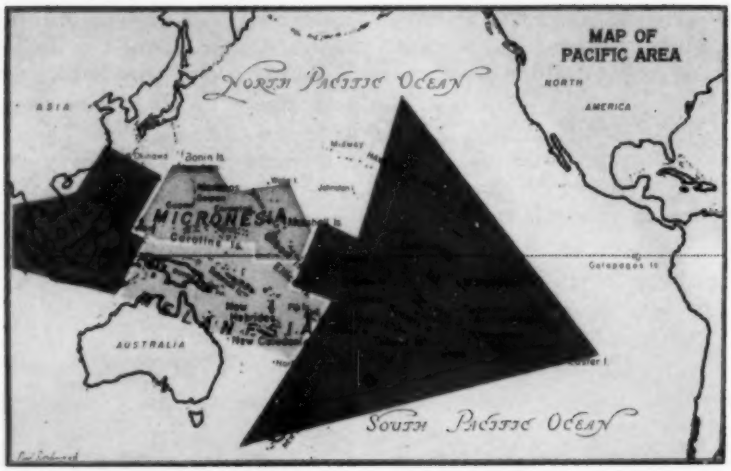

Fig. 1 (Holmes). Map of the Central and South Pacific area.

coma among two or more races under the same conditions and among each race separately under different conditions might be of far greater value as they might disentangle the relative effects of heredity and environment.[59]

As an example, such a study could embrace comparative population surveys among selected Polynesian, Chinese, Japanese and white groups in Hawaii and among similar groups in Samoa, Taiwan, Japan and United States.

American Samoa. Lehine,[38] in 1951 examined 1,833 persons and found no glaucoma. Loschdorfer,[41] in 1955, examined 422 people, and found two patients with glaucoma. Durham[23] and Hirschfelder in 1957 examined 564 patients with various types of eye complaints, and found three cases of primary glaucoma of which one occurred in a white man.

Western Samoa. Loschdorfer,[41] in 1955, examined 245 people. He found two cases of primary glaucoma and six cases of absolute glaucoma. Elliott,[17] in 1959, noted that ". . . although it is much rarer, chronic simple glaucoma does occur among full-blooded Samoans."

Nive Island. Loschdorfer,[41] in 1955, examined 1,867 people. He found four cases of glaucoma simplex and two of absolute glaucoma.

Tahiti. In 1957, Jules Verne[78] reported on eye diseases among natives of these islands. Glaucoma was not included on his list.

New Zealand. Hope-Robertson,[31] in 1957, categorically stated that glaucoma is unknown among the Maoris. He based his conclusions on 25 years of private practice in Wellington, New Zealand, on the records of 170 cases of all types of glaucoma admitted to the Wellington Public Hospital during the years of 1953 through 1956, and on personal communications from two other leading New Zealand ophthalmologists. In 1958, R. G. S. Ferguson[28] of Wellington, New Zealand, in a private communication to me further confirmed this finding. However, Pittar,[78] in 1959, on the basis of a survey of ophthalmologists throughout New Zealand was able to trace 13 Maoris who were under care for primary glaucoma. He concluded that it does occur among Maoris but appears to be uncommon.

From the Micronesian Islands, three eye surveys are available.

Nauru Island. In 1948, F. Phillips[55] had examined the eyes of a large group of natives on this island. He did not find a single case of glaucoma.

GLAUCOMA RESEARCH PROJECT

EMPLOYER _____ OCCUPATION _____ DATE _____ 19 59 SHEET No. _____
HOSPITAL or INSTITUTION Private Practice

CASE NO.	NAME	Ethnic Background	SEX M	SEX F	AGE	EYE	Vision	Type of Ref. Error	Examination of Ref. Segment Media & Fundus	Schiotz Reading 5.5g.	7.5g.	10g.	Maloney Pattern Field Screener	Definitive Diagnosis POS.	Definitive Diagnosis NEG.	FURTHER DIAGNOSTIC TESTS
1.	T.S.T.	Japan.	x		44	R	20/20 H			23						
						L	20/20 H			23						
2.	L.K.	Hawn.	x		47	R	20/40		Ptosis	20						
						L	20/30			20						
3.	A.B.	Cauc.		x	70	R	20/70			20						
						L	20/70		Entropion	23						
4.	F.F.	Fil.	x		45	R	20/20			20						
						L	20/20			20						
5.	A.C.	Cauc.		x	59	R	20/60			42	45			x		Peripheral Fields. Water test
						L	20/15			46	50					
6.	C.B.	Fil.	x		52	R	F.2ft		Retinitis pigmentosa	23						
						L	20/200			23						
7.	F.A.L.	Chin.	x		45	R	20/20			28	27		Haydens		x	Peripheral Fields. Water test
						L	20/20			28	27					
8.	C.T.	Cauc.		x	69	R	F.1ft		Aphakia	20						
						L	20/40			20						
9.	A.T.	Japan.	x		46	R	20/20 H			16						
						L	20/20 H			16						
10.	G.F.	Fij	x		46	R	20/25 H			20						
						L	20/24 H			20						

EXAMINER _____

Fig. 2 (Holmes). Chart used in glaucoma detection survey.

Caroline, Marshall and Northern Mariana Islands. From 1948 through 1950, an American Naval Medical Team abroad the U.S.S. Whidbey examined 22,140 natives of whom approximately one-fifth were 45 years of age or over. In their report,[24] they recorded 4,000 people afflicted with diseases of the eyes and the ocular adnexa. Glaucoma was not included on their list.

Marshall, Koror, Ponape, and Truk Islands. Crawford[19] in 1954 examined 2,184 Micronesian natives without finding a single case of primary glaucoma.

Noumea, New Caledonia. Dr. T. C. Lonie,[40] Executive Officer of Health of the South Pacific Commission, in 1957, wrote: "So far as my personal knowledge goes glaucoma is not a common disease among the indigenous people of the Pacific."

Melanesian populations have been surveyed in Fiji, Papua and Australian and Dutch New Guinea.

Fiji. The population of Fiji is fairly equally divided between native Melanesian and East Indians. Small groups of Europeans, part-Europeans and Chinese also inhabit these islands. Ward,[75] in 1944, examined 6,090 persons. He found 11 cases of chronic simple glaucoma: three among Fijians, five among Indians, and one each among Chinese, part-Europeans and Europeans.

Papua and British New Guinea. Ida Mann[42] examined 13,268 persons. She reported glaucoma in only one.

Dutch New Guinea. J. C. Baarspul,[5] from an unspecified number of natives reports no case of glaucoma.

Indonesia. Sie Boen Lian[70] reports that "primary glaucoma is not much seen." When it does occur, the acute and subacute manifestations are more common than glaucoma simplex.

Western Australia. In 1954, Ida Mann examined 10,641 persons. She found 10 cases of glaucoma, two of them occurring in white people.

Central Australia. In 1955, Ida Mann[44] examined the eyes of 438 aboriginal natives and found no glaucoma.

Though ethnically and geographically removed from the Pacific Basin, it is of interest to note that glaucoma is also rare among the Indians of North America,[69] Mexico,[58] and South America.[8]

The foregoing figures are in marked con-

trast with estimates of the blindness caused by glaucoma in other parts of the world. These range from 71 percent in Iceland,[12, 67] 50 percent in the Faroe Islands,[64] 42 percent in Syria,[36] 30 percent among the Negro population of California,[9] 12 to 15 percent in the United States, England and Wales.[64]

It is unfortunate that lack of uniform diagnostic criteria, lack of distinction between narrow-angle and wide-angle glaucoma, incomplete information on the age distribution of persons examined, variations in the methods of examination, differences in collecting and recording statistics and the influence of observer error do not permit accurate comparisons.

The epidemiology of glaucoma has been investigated from the standpoint of age, sex, occupation, ethnic background, geographic location, heredity, vascular disturbances, emotional, neurologic and endocrine aspects, diencephalic control, body build, the effects of diet, alterations in the sugar, protein, cholesterol and electrolyte contents of the blood, smoking, the effect of sleep, drugs, weather, environmental and population characteristics.

Barkan[6] called attention to a statement made by von Graefe "that probably no other subject in ophthalmology has given rise to more controversy than the question of the etiology and nature of glaucoma."

It is not within the scope of this paper to correlate the many proposed etiologic agents with apparent freedom from glaucoma among primitive, nonliterate societies in the Central and South Pacific areas and the Americas. However, in light of statistically significant "resistance" to glaucoma exhibited by natives of the Central and South Pacific and the American Indians, the factors of age, heredity, blood groups, climates and cultures of these areas merit further study.

The late W. Lloyd Aycock,[4] physician and epidemiologist of distinction at Harvard University Medical School, once remarked that the truth in epidemiology had frequently been revealed not by the usual occurrence but by the exceptional one.

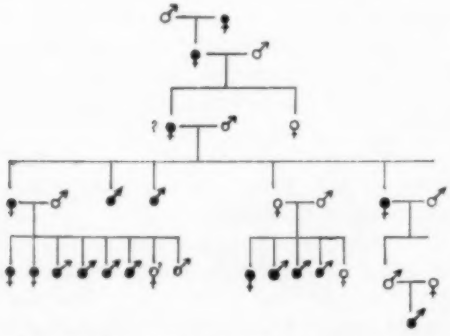

Fig. 3 (Holmes). Six generations of a family with primary glaucoma (Sveinsson).

Hereditary factors

The role of heredity as a means of transmission of chronic simple glaucoma has been repeatedly shown.[63]

Sveinsson's[67] recent report from Iceland adds further emphasis to the genetic transmission of this disease. Of 1,544 patients with primary glaucoma, he found 724 who had close relatives similarly afflicted. He advocated sterilization of married couples with the disease and advised individuals from glaucoma families not to marry!

Among the offspring of glaucoma patients (fig. 3), Becker[7, 8] commented on the high incidence of unrecognized glaucoma at a much earlier age than previously anticipated. The adoption of routine tonography, gonioscopy and suitable provocative tests appears to be practical and effective means to conduct future surveys among the close relatives of known glaucoma patients.

Blood groups

In recent years several independent investigators[15, 16] found evidence which indicates that persons belonging to different blood groups may differ substantially in their susceptibility to certain diseases of adult life. As an example, cancer of the stomach has been linked to blood group A and peptic ulcer to blood group B.

Mourant[50] and Boyd[13] found that blood

group B was seldom encountered among Australian aborigines, Papuans and Polynesians of the Pacific Islands. As was shown in the foregoing discussion, these ethnic groups are seldom afflicted with glaucoma. Blood group B, according to Dunn,[20] occurred in relatively higher proportion of Negroes and Jews than the populations of Europe and America within which they have lived.

Reports by Levatin,[39] Toledo[70] and Weinstein,[76] Packer, Deutsch, Lewis, Oglesby, and Cheij[54] have linked a high percentage of glaucoma to these two ethnic groups.

The problem now arises whether a correlation exists between groups of people who do not have B type of antigen in their blood and do not develop glaucoma and those who possess this antigen and do develop glaucoma; or could this be double phenomena due to chance?

The age factor

The incidence of glaucoma is a function of advancing age: the older the individual, the more likely is the possibility of the development of glaucoma. Relative freedom from glaucoma among natives of the Pacific Islands and American Indians may be ascribed to their shortened life span. Based on statistics of the Hawaii State Board of Health, the average life expectancy of Hawaiian and part-Hawaiian males is 61 years, and of females 64 years. These figures are seven years less than those given for the mainland population, which is males 68 years, females 71 years.

The average life expectancy of Navajo Indians has been estimated to be from 30 to 40 years.

It should be kept in mind that in primitive societies reliable information regarding the age factor is difficult, if not impossible, to obtain.

Effects of the weather

Changes in the weather are reflected in the blood pressure, pulse, body temperature, urine, and in virtually all the metabolic and chemical processes of the body.[28]

Steindorff,[65] Pillat[66] and Weinstein[70] and others noted that acute attacks of glaucoma were often associated with meteorologic changes. Sveinsson[67] advanced the belief that the windy, harsh weather in Iceland along with prolonged darkness of the cold winter may initiate vascular changes in the eye that result in increased intraocular pressure. Chandler and Trotter found glaucomatous attacks commoner during the winter than during the summer months.

Jebejian[36] felt that the high incidence of glaucoma in Syria might be related to the Sirocco which raises the temperature day and night to around 104°F. The Zonda in the Argentines has driven people into temporary insanity. The Solano in Spain is so disagreeable that it is said "seek no favors during the Solano."

On the other hand Fennel[27] believed that the "glorious sunshiny weather" of Hawaii and other Pacific Islands benefits both the psychology and the physiology of the people. An interesting corollary to this thought is the view held by the former medical superintendent[37] of Hawaii State Mental Hospital. He noted that major psychotic episodes in Hawaii were fewer, milder, and less violent than in mental hospitals on the mainland of the United States.

Association with other diseases

The low incidence of primary glaucoma among isolated nonliterate societies corresponds to the low incidence of other hereditary and chronic degenerative diseases among them.

Dental caries, peptic ulcer, ulcerative colitis, coronary artery disease, arteriosclerosis, hypertension, mental disorders, neurodermatitis, iritis, myopia, strabismus and other diseases attributed to heredity and to stressful social and cultural environments have not been observed by the Naval Medical Team aboard the U.S.S. Whidbey that surveyed the health of the residents of the Caroline, Marshall and Northern Mariana Islands in 1948-1950.[34]

The New Zealand *Official Year Book*,[52] for 1956 says, "There is much lower mortality among Maoris for certain diseases which rank high as causes of death among the European population; among these are heart disease, diseases of the circulatory system, diabetes, apoplexy and cerebral hemorrhages."

In Fiji, Maddocks[1] failed to find hypertension among 8,000 native Fijian and Indian manual workers and clerks past 40 years of age. The blood pressures of Europeans, however, invariably rose steeply and continuously after the age of 40 years.

It has been reported that the Navajo Indians have little coronary disease and that the Indians of Peru are not subject to myocardial infarction.

These negative findings parallel those of Opler,[53] who felt that incapacitating and disorganizing illnesses were more prevalent in modern societies than in nonliterate cultures.

Patients with glaucoma frequently have coexisting hypertension and diabetes. Berger and Zimet[10] found diabetes two and a half times more frequent among a group with glaucoma than in a control group.

Packer, Deutsch, Lewis, Oglesby and Cheij[54] noted a high prevalence of arteriosclerosis, hypertension, arthritis and syphilis among 151 persons with subclinical glaucoma.

Physical activity

It has been suggested that physically active people past middle age have a lower incidence of glaucoma than people who are physically inactive.

Miminoshvili[49] reported that sustained physical effort lowers the intraocular pressure in healthy individuals. Hartmann[32, 33] showed that the intraocular pressure may be lowered by muscular and sexual activity. Grant[30] observed reduction in the intraocular pressure when the osmotic pressure of the blood was raised by exercise.

Among primitive cultures, demand for survival requires much in the way of physical activity. Hunting, fishing, trapping and exploring form a regular part of the daily existence.

The mode of action of physical exercise on the intraocular pressure is associated with the excessive production of carbon dioxide, an increase of the plasma bicarbonates and decrease of plasma chlorides.

Biochemical factors

Duke-Elder,[22] Davson, Bárány, Becker, Kinsey, Kronfeld, Harris, Friedenwald, Grant and others have done an enormous amount of basic laboratory and applied clinical research on the role of plasma electrolytes, nonelectrolytes, ascorbic acid, hyaluronic acid, polysaccharides, carbonic anhydrase and its inhibitors and hormones on the production and exchange of aqueous.

Still further studies are needed to investigate the roles played by minerals such as zinc, by vitamins and by toxic agents upon the rate of flow, alteration in permeability, and diffusion characteristics of the aqueous.

It is hoped that with specialized techniques of colorimetry, polarography and emission spectrography, our knowledge of these fields will increase.

Emotions, anxiety, and stress

Tassmann,[68] Schoenberg,[60] Hartmann,[33] Harrington,[68] Hibbeler[35] and Weinstein[76] have shown that the majority of patients with both wide-angle and angle-closure types of glaucoma have a personality pattern which in essence is a type of chronic anxiety neurosis.

Van Alphen and Stokvis[72] and Kasimova noted that in times of chronic social anxiety, such as the Second World War, glaucoma had occurred as a true epidemic disease, and affected persons aged 30 and 40 years twice as often as during the post-war period.

Among primitive people, Fejos[26] felt that the mere observance of a few limitations in diet, dress, work or behavior insured an

ability to maintain good health. Mead[48] demonstrated that the stresses and strains commonly associated with Western cultures were absent among natives of Samoa, and presumably among other primitive people as well.

Future research

Further regional and international collaboration regarding glaucoma appear highly desirable. The value of such co-operation was realized at the XVIII International Congress of Ophthalmology when a group of eye surgeons organized an International Society for the Study of Glaucoma.

Challenge and hope lie in the fact that the prevalence and character of glaucoma differ with populations and countries.

In the republic of Chile,[2] glaucoma has been included among the diseases that are submitted to mandatory research and periodic control under the Preventive Medicine Law.

Among the native, pigmented populations of the Central and South Pacific, glaucoma does not pose a public health problem nor are there laws concerning its control. Examination of the genetic backgrounds, climates, cultures, and ways of living of the people in these areas, however, offers potentially promising clues regarding the epidemiology of glaucoma.

In the decade ahead full realization and effective utilization of a comprehensive ecologic approach to research on glaucoma constitutes one of the outstanding challenges for ophthalmologists, geneticists, biochemists, anthropologists and investigators in related sciences.

1013 Bishop Street (13).

References

1. Anon.: Fiji tests seek answer to high blood pressure. Honolulu Star-Bulletin, April 3, 1960, p. 12.
2. Anon.: Glaucoma control mandatory in Chile. Sight Saving Rev., **27**:3 (Fall) 1957.
3. Alvaro, M., and Mattos, R. B.: Ocular changes in some Brazilian Indians. Tr. Am. Ophth. Soc., **56**:239-246, 1958.
4. Aycock, W. L.: Quoted by Arnold, H. L., Jr.: Psychologic aspects of allergy. Arch. Dermat., **79**: 684-691, 1959.
5. Baarspul, J. C.: Information on eye conditions in Netherlands. New Guinea. S. Pacific Comm. Technical Informa. Circular, 2 July, 1952.
6. Barkan, O.: Primary glaucoma: Pathogenesis and classification. Am. J. Ophth., **37**:724-744, 1954.
7. Becker, B.: Glaucoma 1957-1958. Arch. Ophth., **60**:1112-1150 (Dec.) 1958.
8. ———: (Newell, F. W., editor.) Glaucoma: Tr. First, Second & Third Conference, New York, Josiah Macy, Jr. Foundation, 1956, 1957, 1958.
9. Belloc, M. B., Fowler, D. H., and Simmons, W. D.: Causes of blindness in California. Sight Saving Rev., **27**:98-111, 1957.
10. Berger, A. S., and Zimet, C. N.: Personality features of patients with primary glaucoma. Psychosomat. Med., **21**:389-396 (Sept.-Oct.) 1959.
11. Berger, A. S.: The emotional factor in glaucoma: A review, EENT Monthly, **39**:116 (Feb.) 1960.
12. Bjornson, G.: Prevalence and causes of blindness in Iceland. Am. J. Ophth., **39**:202-208 (Feb. Pt. I) 1955.
13. Boyd, W. C.: Genetics and the Races of Man. Boston, Little Brown, 1955.
14. Brand, I.: The incidence of vascular diseases in glaucoma patients. Ophthalmologica, **128**:281, 1954.
15. Buckwalter, J. A., Wohlwend, E. B., Colter, D. C., Tidrick, R. T., and Knowler, L. A.: ABO blood groups and disease. J.A.M.A., **162**:1210, 1956.
16. ———: Peptic ulceration and ABO blood groups. J.A.M.A., **162**:1215, 1956.
17. Castagno, M. M.: Clinical observations of the effect of tobacco on the Agnioscotoma in glaucoma. Am. J. Ophth., **33**:1431-1433 (Sept.) 1950.
18. Cowan, W. T.: Report of mainland trip. Straub Clinic Proc., **21**:53-57, 1955.
19. Crawford, H. E., Hamman, G. C., and Isaac, L.: Ophthalmological survey of the Trust Territory of the Pacific Islands. S. Pacific Comm. Technical Paper, 67 Noumea, New Caledonia, 1954.
20. Dunn, L. C.: Heredity and Evolution in Human Populations. Cambridge, Mass., Harvard University Press, 1959.
21. Dubos, R.: Mirage of Health, New York, Harper, 1959.
22. Duke-Elder, S.: Glaucoma: (A symposium organized by Counc. Internatl. Organ. M. Sc.), Springfield, Ill., Thomas, 1955.
23. Durham, D.: Personal communication.

24. Evans, P. J.: The natural incidence of ocular disease. Tr. Ophth. Soc. Australia., **27**:37, 1957.
25. Fabricant, N. D.: Weather and well being. Today's Health, Jan., 1955.
26. Fejos, P.: Man, magic and medicine. In Medicine and Anthropology (edited by Iago Goldstone). New York, Internatl. Univ. Press, 1959, pp. 11-35.
27. Fennel, E. A.: Discussion of paper by Bowles, H. E.: Eclampsia and the weather in Hawaii. Hawaii M. J., **8**:194 (Jan.) 1949.
28. Ferguson, R. G. S.: Personal communication, 1958.
29. Gercoff, W.: Influence of weather on eye diseases. Klin. Monatsbl. f. Augenh., **125**:61, 1954.
30. Grant, W. M.: Aqueous production and flow. (In symposium on glaucoma.) St. Louis, Mosby, 1959.
31. Hope-Robertson, W. J.: Ophthalmologic problems in New Zealand. Am. J. Ophth., **46**:661-668 (Nov. Pt. I) 1958.
32. Hartmann, E.: Psychosomatic phenomena in Ophthalmology. Brit. J. Ophth., **33**:461, 1949.
33. ———: Electroencephalography in glaucoma. ACTA XVII Conc. Ophth. (1954), **2**:937, 1955.
34. Hetzel, A. M.: Health survey of the Trust Territory of the Pacific Islands. Armed Forces M. J., **10**:1199-1222 (Oct.) 1959.
35. Hibbeler, H. L.: Personality patterns of white adults with primary glaucoma. Am. J. Ophth., **30**: 181-186 (Feb.) 1947.
36. Jebejian, R.: Blindness in Syria. J. Social Ophth., **11**:16, 1951.
37. Kimmich, R.: Personal communication.
38. Lehine, D.: Eye diseases in American Samoa: A report on Health Service of the U. S. Dept. of H.E.W., Bethesda, Md., 1952.
39. Levatin, P., Hayashida, E., Belloc, N. B., and Weisman, A.: Multiple screening for eye diseases. Am. J. Ophth., **46**:331-338 (Oct. Pt. I) 1958.
40. Lonie, T. C. (executive officer for health, South Pacific Commission): Personal communication, 1957.
41. Loschdorfer, J. J.: General survey on eye diseases in Niue Island, Am. Samoa and Western Samoa, South Pacific Commission. Technical Circular, No. 13, Aug. 1955.
42. Mann, I., and Loschdorfer, J. J.: Ophthalmic survey of the Territory of Papua and New Guinea. Publication Territory of Papua & New Guinea, Port Moresby, 1955.
43. Mann, I.: Ophthalmic survey of the Eastern Goldfields area of Western Australia. Perth, W. A., William H. Wyatt, Govt. Printer, 1954.
44. ———: Ophthalmic survey of the South West Portion of Western Australia, Perth, W. A., William H. Wyatt, Govt. Printer, 1954.
45. ———: Report on ophthalmic findings in Warburton Range natives of Central Australia. Med. J. Australia, Oct. 26, 1957.
46. ———: Researches into the regional distribution of eye diseases. Am. J. Ophth., **47**:134 (May, Pt. II) 1959.
47. Mann, W. L.: Deprivation of sunlight as possible factor in war dropsy: Prison edema, Military Surg., **82**:30 (Jan.) 1938.
48. Mead, M.: From the South Seas. New York, Morrow, 1939.
49. Miminoshvili, S.: The effects of sustained physical effort on intraocular pressure. U. S. Sikhumi, 1958. (Abstracts of Soviet Med., **3**:4, 1959.)
50. Mourant, A. E.: The Distribution of the Human Blood Groups. Springfield, Ill., Thomas, 1954.
51. Montague, A.: Human Heredity. Cleveland and New York, World Publishing, 1959.
52. New Zealand Official Year Book, 1956, p. 108.
53. Opler, M. K.: Culture, Psychiatry and Human Values. Springfield, Ill., Thomas, 1956.
54. Packer, H., Deutsch, A. R., Lewis, P. M., Oglesby, C. D., and Cheij, A. C.: Study of the frequency and distribution of glaucoma, J.A.M.A., **171**:1090-1093 (Oct.) 1959.
55. Phillips, F.: Ophthalmic conditions in the Trust Territory of Nauru, June 1948. South Pacific Commission Technical Information Circular, No. 1, July, 1952.
56. Pinkerton, F. J.: Blindness in Hawaii. Hawaii M. J., **16**:2 (Nov.-Dec.) 1956.
57. Posner, A., and Schlossman, A.: Role of inheritance in glaucoma. Arch. Ophth., **41**:121-150 (Feb.) 1949.
58. Puig, Solanes M., Camacho, E., Heatley, J., and Torsella, J.: Estudio comparativo anatomico y fisiologico do las esttructuras relacionades con el mantenemiento de la presion intreocuaren indegenas Mexicanos, mestizos y blancos, An. Soc. Mex. Oftal., **31**:12-25 (Jan.-Mar.) 1958.
59. Roll, R.: Methods of Geographical Pathology. Springfield, Ill., Thomas, 1959.
60. Schoenberg, M. J.: Role of states of anxiety in pathogenesis of primary glaucoma. Arch. Ophth., **23**:76-90 (Jan.) 1940.
61. Schroeder, H.: Glaucoma simplex: Etiology and treatment. EENT Monthly, **31**:653-656 (Dec.) 1952.
62. Sears, P. B.: The ecology of man (Condon Lecturer). Oregon State System of Higher Education, Eugene, Oregon, 1957.
63. Sorsby, A.: Genetics in ophthalmology. London, Butterworth, 1951.

64. ———: The incidence and causes of blindness, Brit. M. A., London, 1950.
65. Sugar, H. S.: The Glaucomas. St. Louis, Mosby, 1951.
66. ———: The Glaucomas. New York, Hoeber, 1957, ed. 2.
67. Sveinsson, K.: Glaucoma and heredity in Iceland. Acta Ophth., **37**:192-198, 1959.
68. Tassman, I. S.: The role of stress in ocular diseases. Tr. Am. Acad. Ophth., **61**:179-193 (Mar.-Apr.) 1957.
69. Thygeson, P., and Dawson, C. R.: Ophthalmological problems of the American Indians. Tr. Pacific Coast Oto-Ophth. Soc., **40**:49-62, 1959.
70. Toledo, R.: Glaucoma in Negroes. Arch. Brazil Oftal., **15**:35-39, 1952.
71. Vallee, B. L.: Biochemistry, physiology and pathology of zinc. Physiol. Rev., **39**:443-490, 1959.
72. Van Alphen, G. W. H. M., and Stokvis, B.: Psychosomatic effects of intraocular pressure. Netherlands M. J., **95**:31, 1951.
73. Verne, J.: An ophthalmic surgeon in Tahiti. (Editorial) J. Internat. Coll. Surg., **37**:257, 1957.
74. von Graefe, A.: Ueber die Wirkung der Iridektomie bei Glaucom and über den glaucomatosen Process. Arch. f. Ophth., **3**:457, 1857.
75. Ward, B. A.: Ophthalmic survey of Fiji with special reference to the problem of trachoma. Bull. Med. Dept., Suva, Fiji, Nov., 1955.
76. Weinstein, P.: Nervism in ophthalmology: Cortico visceral problems of glaucoma. Ophthalmologica, **127**:164-178 (Mar.) 1959.
77. Elliott, R.: Ophthalmic disease in Western Samoa. Tr. Ophth. Soc. New Zealand 1959. To be published.
78. Pittar, A. C.: Personal communication, 1959. Auckland, New Zealand.
79. Sie Bon Lian: Tropical ophthalmology in Indonesia and adjacent countries. Advances in Ophthalmology. New York, Basel, Karger, 1960, v. 10, pp. 49-175.

CLASSIFICATION AND SURGICAL TECHNIQUES IN IRIDECTOMY*

ARTHUR H. KEENEY, M.D.
Louisville, Kentucky

I. INTRODUCTION

Descriptions of iris surgery usually reiterate incorrect terms, such as complete iridectomy when total removal of the iris is not in the least intended, and suggest that the iris should be "withdrawn and excised." The texts of Blaskovics and Kirby are exceptions. Iris techniques are less important at the moment of intraocular surgery than they are later to aqueous dynamics and final visual restoration. The ultimate significance of aqueous dynamics and restoration of vision is less apparent during residency years and the early career of an eye surgeon. Other factors being equal, final visual acuity after cataract extraction is closely related to pupillary configuration: the larger, the more irregular, or the more eccentric the pupil, the poorer the final acuity.

This study is primarily concerned with iris surgery related to cataract extraction and optic restoration. Many types of iris inclusion procedures for glaucoma are excluded as are dozens of artificial pupil operations dating from William Cheselden's initial iridotomy in 1729. Most surgical procedures to create new openings through updrawn or pigmented secondary membranes may one day be outmoded by the photocoagulation of Meyer-Schwickerath.

II. CLASSIFICATION

To reduce confusion and repetition of incorrect terminology, the following classification, which is based on anatomy of the iris and geometry of the portion attacked, is urged.

SURGICAL CLASSIFICATION

1. Sector iridectomy: incorrectly called "complete," "full," or "breite," is basal by definition.

* From the Section on Ophthalmology, University of Louisville School of Medicine. Presented at the 12th annual clinical conference, Wills Eye Hospital, February 20, 1960.

2. Peripheral surgery: (a) basal iridectomy (basalexzision); (b) midzone (pupillenbildung)—(1) artificial pupil operations and (2) photocoagulation in the aphakic; (c) peripheral iridotomy.

3. Central or sphincterian: (a) stenopaic slit iridectomy for optical purposes (Brudenell Carter's abscission without traction); (b) sphincterotomy.

4. Radial iridotomy (Manolescu, Verhoeff, Cutler), usually requires a small basal dialysis.

5. Total iridectomy (irido-avulsion) for complete anterior synechia in presence of total corneal graft (Castroviejo), or as early treatment in essential atrophy of the iris.

Iris surgery may also be classified according to its objectives which have been widely modified in recent years. Classification of the antiglaucomatous procedures stress the accessibility of the filtration angle. The usually disappointing optical iridectomies of earlier years have been replaced by corneal transplantation but, when they are indicated, they should be minimal stenopeic and sphincterian in type. This minimizes the inevitable distortion of the peripheral cornea.

Corneoscleral suturing has lessened the threat of prolapse and postoperative iritis which prompted Albert von Mooren to add iridectomy to cataract surgery. Mooren felt that any slight opening of the unsutured cataract section postoperatively, with its attendant gush of aqueous, would be less likely to prolapse the iris if a small opening were made at the most common site of extrusion—the 12-o'clock position.

Today iris surgery combined with cataract extraction is most concerned with avoidance of pupillary block. Preoperative study of the retina is facilitated by wider iridectomies. Steroids have generally outmoded the therapeutic iridectomy for uveitis.

Surgical objectives

1. Antiglaucomatous: (a) Basal procedures in acute and pupillary block. (b) Inclusion procedures in open angle. (c) Total iridectomy in essential atrophy of the iris.

2. Optical (stenopeic sphincterian; rarely total).

3. Adjunct to cataract surgery: (a) To lessen iris prolapse. (b) To avoid pupillary block. (c) Episiotomy (pupil less than five mm.).

4. Diagnostic: (a) Conversion of non-sector to sector type. (b) Composite iridectomy of Vogt.

5. Anti-inflammatory (sector).

III. Instrumentation

Iris instruments should be treated with the same care as the Graefe knife. Instruments should be periodically inspected under the corneal microscope. Autoclaving still is the most secure form of sterilization and iris instruments should be autoclaved even though this necessitates scissors being sharpened more often. Smith of India, as well as Chandler and McDonald of this country, have long urged toothless iris forceps. One current eye instrument catalog lists 33 kinds of iris forceps and only one without teeth; another does slightly better, listing 25 different types, five without teeth. Teeth tend to ensnarl a larger amount of iris thereby predisposing to larger colobomas. There is also the hazard, unfortunately not so infrequent as it should be, of toothed forceps injuring the lens capsule, zonule, or hyaloid. To facilitate introduction, forceps should also be slightly curved rather than straight. The finer these forceps, the more discrete and better controlled will be the iridectomy.

Scissors should be gently curved on the flat because straight scissors will produce longer or larger iridectomies. If the scissors are not sharp, irregular tears with tags are produced, tending to form synechia. Except in an atrophic or diseased iris, bleeding is not an appreciable problem even with jagged iris cuts. A single, firm decisive cut will produce a smaller and cleaner coloboma than is achieved with multiple bites. Dangers of iris bleeding have been emphasized so often that many surgeons fear dialyzing the iris root. For nine years I have routinely dialyzed the root for iridectomy at cataract surgery and

have never been troubled by extensive hemorrhage. This may produce slightly more pigment flotation in the diabetic but has not created hemorrhagic problems. Without question, dialysis of the iris root should be done during cataract surgery in all patients with preglaucoma or narrow angles. If the iris spatula is rough at any point, it is also a source of trauma to the iris or hyaloid.

To keep sector iridectomies small, it is desirable not to have an assistant lift the corneal flap, but to withdraw the iris against the gentle pressure of the cornea. On the other hand, peripheral iridectomies in cataract surgery, should be somewhat large and basal; here the assistant may elevate the corneal flap and the direction of scissors application is less important. Small peripheral iridectomies may scar over, as do iridotomies, or become blocked by adhesions to the hyaloid.

For smaller colobomas it has been long recognized that the scissors should be closed in a radial direction rather than tangentially to the limbus. Hooks, particularly if sharp pointed, should be avoided because of possible injury to the capsule and the endothelium.

IV. Technical errors in iris surgery

1. Excision (abscission) of the superficial layers rather than full iris thickness is of trivial cosmetic concern but it leaves a raw iris surface which may produce an anterior synechia. If this extends through the entire iridectomy, the intended purposes of iridectomy are obviated. This error requires reapplication of iris forceps, in which event it is particularly important that the forceps be toothless.

2. If a spector excision is done, excessive dialysis impairs final vision by increasing the breadth of the coloboma and, if episiotomy or sphincterotomy becomes indicated, it handicaps conversion from a peripheral procedure.

3. The 12-o'clock radius must be used for iris surgery to avoid an unsightly eccentric coloboma and increased intolerance to light.

4. In the presence of vitreous loss, of the near-aqueous type as well as formed vitreous, any lesser iris procedure should be converted to a sector iridectomy by excision of the narrowest possible width of sphincter. In the presence of a large basal or peripheral iridectomy, conversion should not be made by simple radial iridotomy because this leaves elongated limbs which give rise to posterior synechia, iris irritation, and thickening of the hyaloid. A small 6-o'clock radial sphincterotomy should also be done in the presence of vitreous loss, to minimize upward migration of the pupil.

5. Injury of capsular and hyaloid with toothed forceps seems unlikely but its occurrence decreases the percentage of intracapsular extractions in many practices.

6. The use of pointed iris scissors, particularly in superior radial iridotomy, and sharp hooks may also increase the percentage of extracapsular extractions.

7. If a sector (basal) iridectomy is desired, the root should be dialyzed and the iris engaged proximal to the sphincter. If the sphincter area is engaged in the forceps, particularly when dialysis is omitted, a small basal flap usually remains to create an anterior synechia.

8. The anterior hyaloid may be ruptured by the most gentle contact with an iris spatula. This is especially true if alpha chymotrypsin has been used. Care must be maintained to keep the iris spatula from slipping beyond the sphincter border if reposition of iris pillars is necessary. With peripheral or nonsphincterian iris surgery, the added hazard of introducing a repositor is not usually needed. If the vitreous face is forward or convex following delivery of the lens, such iatrogenic trauma will produce vitreous loss.

9. Dull scissors are frequent sources of jagged colobomas and taggles adhering to the hyaloid or cornea. Autoclaving of these instruments makes it necessary to test them frequently and sharpen them often.

Summary

The frequent occurrence of postoperative

pupillary irregularities indicates a need for greater attention to details of iris surgery, particularly in cataract extraction. Proper terminology aids the ophthalmologist in clear thinking about iris procedures. The term "sector iridectomy" is urged to replace the incorrectly used "complete iridectomy." A minute dialysis of the root should be done to insure that sector, basal, and peripheral iridectomies do not leave small iris tags to adhere to the endothelium or hyaloid. Peripheral iridectomies, in the main, should be large but yet preserve a round central pupil; sector iridectomies should be as narrow as possible. However, conversions from peripheral to sector iridectomies should be done by sphincterectomy rather than radial snip to keep loose iris limbs from irritating the hyaloid. Because peripheral iridectomies, like small peripheral iridotomies, scar over easily, they may become ineffective in avoiding pupillary block. Optical iridectomy, although rarely indicated, should be by the stenopeic sphincterial technique.

Iris scissors should be sharp and gently curved on the flat. Iris forceps should be fine, toothless, and also gently curved. Iris spatulas must be well polished. These instruments deserve as much care and critical attention as the Graefe knife.

1406 Heyburn Building (2).

References

Beetham, W. P.: Cataract extraction with iridodialysis. Tr. Am. Ophth. Soc., **39**:104-115, 1941.

Blaskovics, L., and Kreiker, A.: Eingriffe am Auge. Stuttgart, F. E. Verlag, 1938.

Bowman, W.: Collected Papers. London, Harrison and Sons, 1892, v. 2, pp. 283-322.

Graefe, A. von: On iridectomy as a means of treatment; On iridectomy in glaucoma; Additional clinical remarks on glaucoma; Glaucomatous diseases and their treatment by iridectomy. London, The New Sydenham Society, 1859, pp. 251-380.

Grimsdale, H., and Brewerton, E.: A Textbook of Ophthalmic Operations. London, Bailliere, 1937, pp. 185-188; 240-250.

Kirby, D. B.: Surgery of Cataract. Philadelphia, Lippincott, 1950.

Verhoeff, F. H.: Cataract extraction with modified iridectomy. Ophth. Rec., **15**:335, 1906.

Ziegler, S. L.: History of iridotomy. Tr. Sect. Ophth. A.M.A., 1908.

EXPULSIVE HEMORRHAGE DURING RETINAL DETACHMENT SURGERY*

A case with survival of the eye after Verhoeff sclerotomy

J. Reimer Wolter, M.D.
Ann Arbor, Michigan

In 1915, Verhoeff[1] suggested doing a sclerotomy in cases of expulsive choroidal hemorrhage. This treatment has since then proved to be helpful in saving a few eyes that would otherwise have been lost because of this severe complication of intraocular surgery. Verhoeff[1] himself treated a case of expulsive choroidal hemorrhage which occurred during an operation for glaucoma. He used several scleral punctures with a Graefe knife to release the choroidal hemorrhage and saved the eye. Vail[2] also reported the successful treatment of a case of expulsive hemorrhage which occurred during glaucoma surgery. He used immediate sclerotomy 14 mm. back from the limbus with a Graefe knife and also saved the eye.

Vail[2] was the first to treat successfully an expulsive choroidal hemorrhage following cataract extraction. In this case he again used Graefe knife sclerotomy 15 mm. back from the limbus and twisted the knife blade to release the blood. The hemorrhage occurred one day following the cataract extraction and the eye was saved.

* From the Department of Ophthalmic Surgery of the University of Michigan Medical Center.

Duehr and Hogenson[3] were the first to save an eye with expulsive choroidal hemorrhage during cataract extraction by immediate sclerotomy. They used the Graefe knife 12 mm. from the limbus and also twisted the knife blade to release the blood. Velhagen[4] treated a case of choroidal hemorrhage of the expulsive type occurring at the time of suture removal after cataract surgery. He did a sclerotomy nine days after occurrence of the hemorrhage. In a recent paper Henderson (Mayo Clinic)[5] reported the survival of an eye with expulsive choroidal hemorrhage at the time of cataract extraction which he treated with immediate scleral puncture, using a Graefe knife, in the area of the ora serrata. His patient had vision of 20/40 in the involved eye seven years after the operation.

The present case report deals with the occurrence of expulsive choroidal hemorrhage during scleral imbrication for retinal detachment. This complication in the only eye of a hypertensive patient was successfully treated by Verhoeff sclerotomies.

Case report

This 47-year-old white man came to this Eye Clinic on October 5, 1959. He gave a history of having lost his left eye in an accident when he was 10 years old. Two months ago he had noted a gradual loss of vision in his right eye with a "curtain" coming over his visual field from the nasal side. He went to an "eye specialist" in his town who told him that he had a cataract. The patient was admitted and operated for cataract. The cataract extraction was complicated by vitreous loss. No improvement of vision was obtained and a retinal detachment was found after the lens was removed. With this retinal detachment in his only aphakic eye the patient was admitted for surgery.

The eye examination at admission revealed the vision to be: O.D., finger counting eccentrically at three feet. The eye was red. The scar line of the cataract surgery at the upper limbus was well visible at the slitlamp. Silk sutures were still in place. Flare and cells were seen in the anterior chamber. There was a total iridectomy and strands of loose vitreous extended into the anterior chamber. There were some white cells in the anterior vitreous. The retina was totally detached. It was billowing temporally and a group of four retinal holes was seen peripherally at about the 10-o'clock position where vitreous strands seemed to pull the retina forward. The general examination revealed a labile hypertension which averaged about 160/110 mm. Hg. The patient was put on hypertension treatment with Reserpine (0.25 mg., t.i.d.).

The eye was operated on October 8, 1959. A scleral imbrication from the 7- to 1-o'clock positions with an encircling polyethylene tube was planned. Under general anesthesia the temporal conjunctiva and the superior and temporal rectus muscles were detached and the sclera was exposed. The sclera was incised 15 mm. back from the parallel to the limbus. Starting from this incision backward a scleral trough of four to five mm. in width was prepared from the 7- to 1-o'clock positions. Surface diathermy was applied all over the choroidal surface of the trough. Watching the intraocular pressure during the diathermy by finger palpation it was not felt that the intraocular pressure rose much over 30 mm. Hg. Then the perforation of the remaining scleral lamellae and the choroid was done with a needle at about the 8-o'clock position within the trough. Clear retroretinal fluid came out in a gush. The eye softened. After some massaging, the globe was quite collapsed. No suction was used. A polyethylene tube was put in place and the first suture to close the scleral imbrication was just being placed when suddenly the collapsed globe was seen to fill up again. Palpation revealed that it had become stony hard within a few seconds. It is my guess that the intraocular pressure at this time must have been at least 80 mm. Hg. It was realized at once that an expulsive choroidal hemorrhage had occurred. With the ophthalmoscope a black mound was seen in the eye at about the 2-o'clock position. The blood pressure at this time was 200/130 mm. Hg.

I am unable to say exactly how long after the occurrence of the expulsive hemorrhage the first sclerotomy was done since no one in the operating room watched the time during this period. I had heard about the possibility of saving an eye with expulsive hemorrhage by immediate sclerotomy. Dr. Fralick, the chief of this Eye Clinic, happened to be close by and reassured me that a sclerotomy was the thing to do. This was done, probably at about five minutes after the hemorrhage occurred, by scratching in through the sclera with a Bard-Parker knife at the 2-o'clock position about 14 mm. back from the limbus. Blood of bright red color gushed out from the scleral incision. After about five minutes, the bleeding stopped and the eye was very soft again. However, when the suturing of the sclera at the trough was taken up the eye suddenly filled up again and became just about as hard as it was after the first bleeding. No blood came out of the sclerotomy wound at the 2-o'clock position. The ophthalmoscopic examination had become very difficult because of cloudy cornea and vitreous. It was my impression, however, that another black mound had appeared in the eye, this time at the 5:30-o'clock position. A second sclerotomy was done in this area. Blood came out and the globe became softer. However, it did not collapse again. We thought that probably blood coagulation had occurred in the choroidal hemorrhage. After this it was not possible to do the scleral shortening and tube implantation.

Only a slight imbrication could be done by suturing the scleral margins of the trough. The wounds of both sclerotomies were left open for further drainage. The eye pressure at the end of the operation was about normal.

To my surprise the patient was not blind after this surgery and the described complication. On November 26, 1959, his vision was 20/400 with correction. His upper retina appeared to be attached. The retina was detached below and a retinal bulla extended from the 5- to 9-o'clock positions. A rather large retinal hole was seen at the 6:30-o'clock position. The patient was again admitted to this eye clinic and operated on November 27, 1959. A scleral imbrication from the 3- to 9-o'clock positions (lower half) with polyethylene tube implant was done. This time the blood pressure was carefully watched and everything was prepared to lower the blood pressure in case it should go up. However, a deep anesthesia resulted in a blood pressure of 150/80 mm. Hg at the time of perforation of the globe. It was successfully tried to prevent gushing out of the retroretinal fluid. No complications occurred.

At the last examination on April 13, 1960, the patient had a vision of 20/200 with +9.0D. sph. Externally, his eye appeared normal. The anterior chamber showed no flare or cells. The vitreous exhibited posteriorly rather dense accumulations of corpuscular opacities and coarse vitreous strands. The retina showed fixed folds but was generally in its normal place. A good buckle was seen inferiorly and there were good diathermy reactions above, temporally and inferiorly. The optic nerve appeared rather white. The patient stated that his vision still seemed to improve continuously.

Comments

The experience of this instructive case permits the statement that an eye with expulsive choroidal hemorrhage during retinal detachment surgery can be saved by a Verhoeff sclerotomy. There is no doubt that the eye in the present case would have been lost through occlusion of the retinal blood vessels by the extremely high intraocular pressure if the expulsive hemorrhage had not been relieved. Considering the poor prognosis, it can be said that, when the patient was first seen in this clinic, no better vision than about 20/200 was expected after successful surgery. Thus, it seems that not very much retinal function was lost by the occurrence of the expulsive hemorrhage. This impression is supported by the experience of Verhoeff, Vail, Duehr and Hogenson, and Henderson who also lost relatively little of the retinal function in their cases of expulsive hemorrhage treated successfully with sclerotomy.

The occurrence of the expulsive hemorrhage in the present case can be explained by three possible contributing factors: (1) the hypertension, (2) the relatively sudden release of the retroretinal fluid after the intraocular pressure was somewhat increased following extensive surface diathermy, and (3) the fact that the patient had had cataract surgery only about a month before. The second operation for retinal detachment showed that the expulsive hemorrhage could probably have been avoided by a deeper anesthesia and by prevention of the sudden release of the retroretinal fluid.

Summary

Expulsive choroidal hemorrhage during retinal detachment surgery occurred after release of the retroretinal fluid in the only eye of a 47-year-old hypertensive patient. The eye was saved by evacuation of the expulsive hemorrhage through a Verhoeff sclerotomy. It seems that only little retinal function was lost through this complication. Attachment was achieved without complications at a second operation for retinal detachment.

University Medical Center,
Eye Clinic.

References

1. Verhoeff, F. H.: Scleral puncture for expulsive subchoroidal hemorrhage following sclerostomy: Scleral puncture for postoperative separation of the choroid. Ophth. Rec., **24**:55, 1915.
2. Vail, D.: Posterior sclerotomy as a form of treatment in subchoroidal expulsive hemorrhage. Am. J. Ophth., **21**:256, 1948.
3. Duehr, P. A., and Hogenson, C. D.: Treatment of subchoroidal hemorrhage by posterior sclerotomy. Arch. Ophth., **38**:365, 1947.
4. Velhagen, K.: Die Behandlung von Aderhautabhebungen und postoperativen intraocularen Blutungen. Klin. Monatsbl. f. Augenh., **133**:776, 1958.
5. Henderson, J. W.: Expulsive subchoroidal hemorrhage associated with cataract extraction: Report of a case with survival of the eye. Am. J. Ophth., **49**:791, 1960.

OCULAR SIGNS ASSOCIATED WITH HYDRANENCEPHALY*

KEVIN HILL, M.D., DAVID G. COGAN, M.D., AND PHILIP R. DODGE, M.D.
Boston, Massachusetts

Ocular signs are often prominent features of hydranencephaly yet they have received only cursory notice in the literature. In a review of 12 cases of cortical blindness in young children seen by one of us, three were associated with hydranencephaly. We are therefore prompted to bring this entity to the attention of ophthalmologists and to report these cases with the ocular pathologic findings in one of them.

Hydranencephaly is a developmental anomaly in which the cerebral hemispheres are reduced, in whole or in part, to membranous sacs filled with cerebrospinal fluid. The meninges and cranium are intact in contrast to the state of anencephaly in which these too are deficient. The head is usually of normal size or only slightly enlarged, whereas in typical hydrocephalus which has reduced the cortex to the degree seen in hydranencephaly, the cranium is grossly enlarged. Pathologically, the membranous sacs are composed of the leptomeninges fused with gliotic cortical remnants. The basal ganglia and midbrain are usually present although they may be imperfectly developed. The pons, medulla and cerebellum are often normal.

Cruveilhier,[1] in 1835, was apparently the first to describe the anomaly, terming it *l'anencephalie hydrocephalique,* although a case described earlier by Richard Bright[2] may have been an atypical instance of the condition. Spielmeyer[3] is credited with first having used the term hydranencephaly in reporting its occurrence in nonidentical twins. Since, then, numerous reports have appeared in the neurologic and pediatric literature.

Various pathogenetic mechanisms to explain hydranencephaly have been proposed. Spielmeyer concluded that circulatory disturbances late in fetal life were responsible. Norman[4] felt that the distribution of the lesions was consistent with obstruction of the internal carotid arteries during gestation and this concept received some support from the experimental studies of Vogel and McClenahan[5] who produced cystic cerebral lesions similar to hydranencephaly by occluding the major cerebral arteries of chicks. Marburg and co-workers[6,7] believed phlebostasis and phlebothrombosis, particularly in the drainage area of the great vein of Galen, were responsible for the development of hydranencephaly.

Yakovlev and Wadsworth[8-10] considered the defect represented a failure of development of the cerebral mantle in the early stages (not later than the second month) of fetal life and proposed the term schizencephaly as being more descriptive of the pathogenesis. Cohn and Neumann,[11] on the other hand, being unable to demonstrate in their case the pia-ependymal seam which Yakovlev and Wadsworth described as characteristic of schizencephaly, felt that hydrancephaly was more probably a primarly neuronal dysplasia representing a severe degree of bilateral porencephaly. Edinger and Fischer,[12] Bettinger,[13] Muir,[14] and Thelander, et al.,[15] appeared to agree with this. Crosby, in discussing Watson's[16] second case, thought the development of the brain was probably normal until at least the fifth month of gestation and thereafter the forebrain underwent regression.

It appears most likely, however, that the pathogenesis of this condition is multiple for in recent years examples of hydranencephaly associated with aqueductal narrowing due to infection have been reported.[17] This observation suggests that in these instances an encephaloclastic process operating in con-

* From the Massachusetts Eye and Ear Infirmary and the Howe Laboratory of Ophthalmology, Harvard Medical School (Dr. Hill and Dr. Cogan) and from the Department of Neurology, Harvard Medical School, and the Neurology Service, Massachusetts General Hospital (Dr. Dodge). Presented at the alumni meeting of the Massachusetts Eye and Ear Infirmary, April 26, 1960.

junction with an obstruction to the flow of cerebrospinal fluid may result in an atypical hydrocephalus which has been classified as hydranencephaly.

Clinically, the infants may appear normal for the first week or two of life unless enlargement of the head or systemic anomalies are present. Indeed, Hamby, et al.,[18] cite one case in which the infant was considered normal at one week of age by a competent pediatrician and was then adopted, only to manifest the condition at a later date. Retardation of growth and development are usually noticed within the first month. Some enlargement of the head, irritability and convulsions are commonly but not invariably present. In those cases in which the eyes are mentioned, marked impairment of vision has been prominent.

Of great diagnostic value is the fact that the cranium transilluminates, unless there has been considerable bleeding into the ventricles.[19, 20] Ventriculography is also helpful in outlining the extent of the cerebral defect. As might be expected with such an extensive cortical defect, there is often minimal or no electrical activity on electroencephalography. Methylene blue, phenolsulfonphthalein or other dyes may fail to appear in the lumbar subarachnoid space after injection into a lateral ventricle in those cases with obstruction of the aqueduct of Sylvius. (The so-called Dandy test[21].)

Infants with hydranencephaly usually survive only a few months, although the case of Crome and Sylvester[22] survived four and a half years. Of 14 cases collected from the literature plus two cases of their own, Johnson, et al.,[23] found that two were stillborn, 11 died within one month and three survived between 25 and 45 months. In the 20 cases reported by Alexander, et al.,[19] eight died at an average of five and a half months while the 12 survivors at the time of their report ranged in age from six to 26 months.

Ocular signs associated with hydranencephaly have been mentioned in some of the reported cases of this disorder but to our knowledge they have not been reported in the ophthalmic literature nor has their significance been discussed. Of the three cases reviewed by us, none of the patients survived longer than eight months but only one came to autopsy. The clinical ocular findings in this case, as well as the ocular pathology, would appear to be of sufficient interest to warrant reporting them in some detail. We are also adding a brief description of the clinical findings in the other two cases.

Case reports

Case 1

C. B., a 28-day-old white girl, was admitted to the hospital for investigation of mild hydrocephalus. The child was the product of a full-term pregnancy and was delivered by caesarian section. At birth the head circumference was noted to be 15 inches. No other abnormalities were noted and for the first 10 days of life the child's development appeared satisfactory. For the two weeks prior to admission, however, the parents noted the child had frequent transient seizures during which she would stiffen momentarily, followed by twitching of both arms and, on occasion, both legs.

The child's mother had two episodes of abdominal cramps, nausea, vomiting and diarrhea lasting two to three days during this, her second pregnancy. One such episode occurred at eight weeks; the other at seven months. She also had a severe "chest cold" lasting two to three weeks during the third month of pregnancy. A similar severe "chest cold" occurred during the third month of her first pregnancy which terminated in the full-term delivery by caesarian section of a hydrocephalic infant who died. She had three series of X-ray films of the pelvis in the ninth month of her first pregnancy but no X-rays during the second except for two dental films (not a full dental survey) in the first month.

The family history is of interest in that one of the mother's siblings had a meningomyelocele and another had a child with spina bifida.

Physicial examination. On admission the child was noted to have a large head (circumference, 16 inches) compared to her body size (weight, seven pounds, 14 ounces; height, 19 inches; chest circumference, 12.25 inches and abdominal circumference, 11.25 inches). In addition there was separation of the lambdoidal, coronal, and sagittal sutures, dilatation and bulging of the fontanelles. The entire cranium transilluminated (fig. 1). All extremities moved normally and she fed actively. Response to pinprick was equal in all extremities although on examination a few days later there appeared to be some diminution of response in the lower extremities. Patellar and biceps tendon reflexes were present and equal. The Moro reflex was active as were the sucking and grasping reflexes. Dorsiflexion of the big toes occurred on plantar stimulation. Except for the optic

Fig. 1 (Hill, Cogan and Dodge). Transillumination of the skull of patient C. B. Photograph taken in a dark room with the light directed against the opposite side of the patient's head.

nerves, no abnormalities of the cranial nerves were present.

Ocular examination. The child had a distinct and strong blepharospasm when light was shone in her eyes but otherwise did not appear to see. She did not respond to thrust movements nor did she follow light or moving objects. The pupils were four mm. in diameter, equal and responded definitely, albeit sluggishly, to light with achievement of full miosis. The eyes appeared to rest in approximately the primary position with possibly slight upward deviation and moved conjugately in all directions. With rotation of the body the eyes made a full contraversive deviation followed by a few nystagmoid jerks. The lids blinked spontaneously while under observation. Corneal sensation was intact. The media were clear.

The right optic disc was a dense white color of uniform texture with one abortive vessel extending from the center to the nasal margin and two smaller vessels at the temporal margin. None of these vessels was seen to extend into the retina. The retina itself was orange in color with more than usual pepperlike pigmentation. In the extreme periphery nasally was an ill-defined white mass. The left fundus was exactly the same except that no white mass was present. A diagnosis was made of massive gliosis of the disc, and possibly of the periphery, with curious absence of retinal vascularity. Impressive was the preservation of the optical blinking reflex (blepharospasm in response to light) with fundi of this appearance.

Laboratory studies. On radiography, there was enlargement of the cranium, thinning of the bones of the calvarium and wide separation of the sutures. No intracranial calcifications were noted. A ventriculogram was done and phenolsulfonphthalein was injected into the ventricular cavity. No dye was recovered from the lumbar subarachnoid space although it was subsequently detected in the urine. Pneumoencephalographic studies revealed a picture consistent with marked cerebral dysplasia or agenesis. The electroencephalogram was grossly abnormal with no clearly detectable electrical activitiy. A left carotid arteriogram outlined threadlike anterior and middle cerebral vessels (fig. 2).

Course. The child died of meningitis five weeks after admission. A few days before death the ocular findings, including blepharospasm on photic stimulation, were noted to be unchanged.

Post-mortem examination. The cerebral mantle was reduced to a thin membrane which enclosed a fluid filled cavity. The basal ganglia, brain stem and cerebellum were relatively intact. The diagnosis of hydranencephaly associated with aqueductal narrowing secondary to subependymal gliosis was established. The type of periaqueductal reaction suggested a chronic inflammatory disease process other than the terminal meningitis although the etiology was not apparent. A detailed report of the neuropathologic findings will be presented subsequently.

Ocular pathology. The anterior segments were those of normal infantile eyes.

The posterior segments were examined prior to fixation. The nerve heads appeared to be of approximately normal size and, for post-mortem material, of normal color. The central cup appeared abnor-

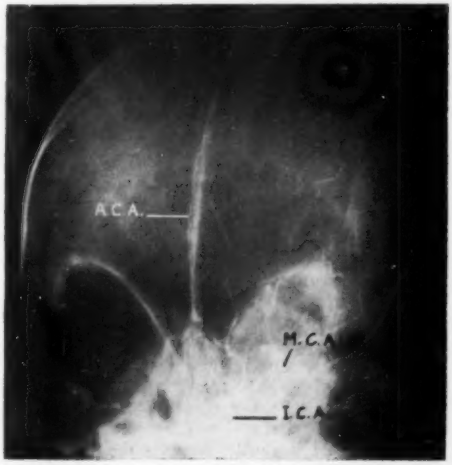

Fig. 2 (Hill, Cogan and Dodge). Left carotid arteriogram in Case 1 (C. B.). The anterior cerebral artery (A. C. A.), middle cerebral artery (M. C. A.) and internal carotid artery (I. C. A.) are indicated.

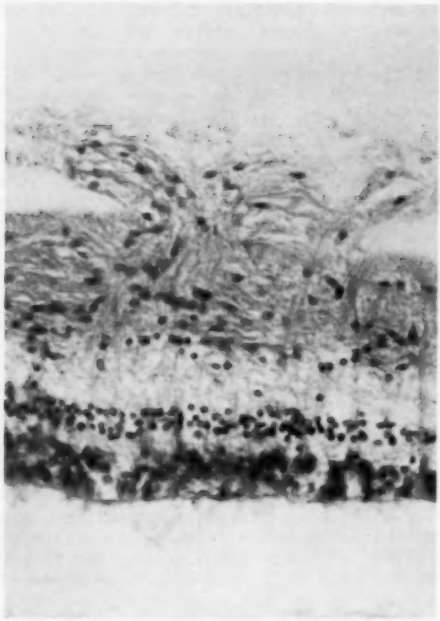

Fig. 3 (Hill, Cogan and Dodge). Microscopic section demonstrating the major abnormalities in the retina (hematoxylin-eosin).

mally large but did not extend to the edge of the disc. The macula was evident by the usual post mortem folds and by the coloration of the underlying pigment epithelium. Only a trace of retinal vessels could be seen, one coursing vertically from the disc as a faint white line and two coursing horizontally as thin columns of blood. The choroidal background did not appear abnormal.

Microscopically, the major abnormalities in the retina were extensive gliosis of the inner retinal layers, almost complete absence of ganglion cells, abnormal prominence of Müller's fibers, attenuation of the bipolar cell layer, and abnormal rod and cone cells (fig. 3). These will be described serially followed by a description of the optic nerve and choroid. The features were identical in the two eyes.

The inner retinal layers were replaced by a compact bundle of glial tissue that occupied more than half the retina at the posterior pole and progressively lessened to a negligible thickness at the equator. It was made up of glial cells that were oriented chiefly parallel to the surface of the retina but fenestrated by Müller's fibers that departmentalized it vertically. At irregular intervals the glial tissue had erupted through the inner surface to show efflorescent proliferation and a membrane on the inner surface of the retina (fig. 4).

Vessels were occasionally found in this inner retinal layer but all were markedly attenuated. A few ganglion cells were found. No hemorrhages, transudates, nor cytoid bodies were present.

Müller's fibers were prominent and extended the full thickness of the retina as they commonly do in various retinopathies.

The bipolar cell layer was markedly attenuated. The number of cells making up this layer was approximately half that of a normal infant's bipolar layer. The basophilia of their nuclei also varied but these changes may have been autolytic alterations. The inner reticular layer was of normal size but the outer reticular layer was scarcely identifiable.

The outer retinal layers were profoundly altered. Only a few abortive cones were recognizable but an abundant granular debris was present between the retina and pigment epithelium suggesting that post mortem changes had occurred to some extent. The outer nuclear layer which is normally made up of cells having uniform small round nuclei consisted of cells of varying sizes and shapes. Many were obviously glial cells. Yet the outer limiting membrane was everywhere intact and no cells were to be found between it and the pigment epithelium. Nor was there fusion of the retina to the choroid in any place.

The nervehead showed a large but shallow cup and a paucity of nerve fibers. The central vessels in the nerve head appeared normal (fig. 5). The retrobulbar portion of the optic nerve showed no recognizable myelin (in hematoxylin-eosin) and a replacement of the normal architecture by proliferated fibroglial tissue. The sheaths were of normal thickness and not perceptibly distended. The vaginal spaces, however, contained cells with a granular cytoplasm suggestive of macrophages.

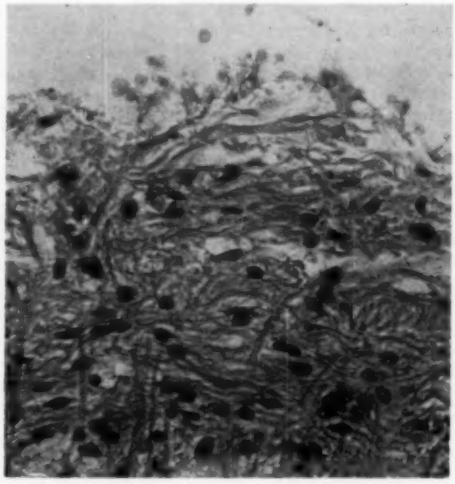

Fig. 4 (Hill, Cogan and Dodge). Efflorescent proliferation of glial tissue forming a membrane on the inner surface of the retina. Müller's fibers are prominent as vertically coursing dark lines in the photomicrograph (hematoxylin-eosin).

Fig. 5 (Hill, Cogan and Dodge). Margin of the optic disc and the adjacent retina with a normal appearing central retinal vessel extending to the edge of the optic cup, gliosis of the inner retinal layers and a glial membrane on the inner surface of the retina (hematoxylin-eosin).

The choroid was normal except for suggestive fibrosis of its outermost layers and a paucity of pigment. The pigment epithelium was normal.

CASE 2

J. A., a white girl, was noted at birth to have generalized fibrous ankylosis of the joints (arthrogryposis multiplex congenita), paraplegia with a paralyzed bladder and rectum, and hydranencephaly. The cranium transilluminated; air study revealed a large cranial cavity without recognizable cerebral cortex; and the electroencephalogram showed no clearcut electrical activity. The clinical ocular findings are listed in Table 1.

The child was treated with several ventricular taps for an enlarging head. Subsequently she was institutionalized and died of an intercurrent infection at the age of eight months.

CASE 3

D. C., a white girl, presented at 17 days of age with an acute bacterial conjunctivitis which responded to antibiotic therapy. At that time she was noted to be hypothermic and to have widened fontanelles. Further investigation established the diagnosis of hydranencephaly. The cranium transilluminated; air study revealed a large cranial cavity and the Dandy test demonstrated a block between the ventricles and the lumbar subarachnoid space. Toxoplasma dye tests on the serum of the patient and of her mother were negative. The clinical ocular findings are summarized in Table 1. At craniotomy a thin membrane was found overlying a large fluid-filled cavity in which the choroid plexus was hanging free. At the base of the cavity, normal appearing basal ganglia and hypothalamus were seen. The membrane was biopsied and was found to consist of astrocytes and glial fibrils (identified by phosphotungstic acid-hematoxylin staining).

The patient was institutionalized and subsequently died at the age of four months.

COMMENT

Of approximately 60 cases of hydranencephaly collected from the literature, half had no description of ocular findings. Of the remainder, the ocular findings may be grouped as follows:

1. VISUAL IMPAIRMENT

When described, it was usually noted the infants failed to follow a moving light or

TABLE 1

CLINICAL OCULAR FINDINGS IN HYDRANENCEPHALY

	Case 1	Case 2	Case 3
Vision	Did not appear to see, blepharospasm to light	Did not appear to see, blepharospasm to light	Did not appear to see, blepharospasm to light
Pupils	Round, regular and equal, sluggish but definite reaction to light	Equal, reactive to light	Equal, reactive to light and to pain around the face
Extraocular movements	Ocular excursions full. Contraversive movement of eyes followed by nystagmoid jerks on rotation of body	Ocular excursions full. Horizontal nystagmus on lateral gaze, normal nystagmus response to rotation of body	Contraversive movement of eyes without nystagmus on rotation of body
Fundi	Massive gliosis of optic discs and periphery with apparent absence of retinal vessels	Optic discs well outlined, slightly pale (normal for infant), no abnormalities	Optic discs pale (? normal for infant). Normal retinal vessels. No abnormalities
Corneal reflex	Intact	Intact	Intact

other conspicuous object. In two cases, however, it was noted that some vision was present.[11, 24] Blepharospasm in response to light was present in several patients who were otherwise believed to be blind.

2. Pupillary reaction to light

This was usually described as normal, although in two cases[25, 26] the pupils were dilated and fixed, in two others[16, 22] the reaction was said to be sluggish, while in another case[23] only one pupil was described and it was miotic and fixed.

3. Extraocular movements

Most of the cases had some ocular motor disturbances. Strabismus, convergent or divergent, inco-ordinated ocular movements and deviations of conjugate gaze were present in the majority. Nystagmus, horizontal and, in one instance, rotary, was also observed.

4. Appearance of fundi

Description of the fundi in most cases was limited to the optic discs which usually were said to be pale. Optic atrophy, however, was specifically noted in only a few cases and less than half of these were accompanied by abnormal pupillary reactions. Bilateral chorioretinitis was described in two cases,[18, 22] one of which[22] was studied pathologically. One case[18] was said to have pale retinas and another[27] was noted to have an abnormal distribution of the retinal artery without further descriptive details. No other retinal abnormalities were reported in any of these cases, several of which were specifically noted to have normal fundi.

5. Size of globe

Muir[14] stated that microphthalmia is common but we could find only three cases[14, 26, 27] in which this was observed.

One of the most striking ocular signs in these cases of hydranencephaly is the apparent inability to see despite preservation of the pupillary light reflex, that is, cortical blindness. This is consistent with the neuropathologic findings in which the cerebral cortex is absent or nearly so. In those instances where some vision appeared to be present, some occipital cortex was found at autopsy.

The preservation of the optical blinking reflex (blepharospasm in response to light) in these cases is of considerable interest. Since many of these cases, including our own, have shown no functional cerebral cortex, the pathways for blepharospasm in response to light must be subcortical in these

infants. However, in adults with cortical blindness, the optical blinking reflex is absent and this has been interpreted as evidence for the existence of cortical pathways subserving this reflex in adults.[28, 29]

The various disturbances of ocular motility as well as those instances in which ocular motility appeared to be normal are consistent with the variation in the extent of involvement of the nervous system. A maintained deviation of the eyes with rotation of the body is what one would expect with decortication. It is, therefore, somewhat surprising that some cases, although not all, developed a nystagmus on rotation of the body. Thus in our three cases normal nystagmus occurred in one case, nystagmoid jerks in a second case, and no nystagmus in a third case.

The fundus abnormalities of our first case appear to be unique. No similar abnormalities were noted in the fundi of our other two cases nor did any of the previously reported cases appear to have comparable changes. The absence of retinal vessels clinically was especially remarkable and was noted by several competent observers. Post-mortem examination did reveal a few retinal vessels but these were very small and thus, presumably, escaped detection during life. The marked attenuation of these vessels may be analogous to the state of the cerebral vessels in other cases of hydranencephaly. Angiographic and post-mortem studies have shown many instances of attenuation of cerebral vessels, particularly the branches of the internal carotid arteries. In our patient the cerebral vessels were threadlike on angiography and at postmortem examination. In this respect our findings agree with those of Poser, et al.,[30] who demonstrated that the defect is not, in all instances at least, a consequence of an absence of cerebral vessels.

The marked gliosis of the retina in our case is another noteworthy feature of the ocular pathology, the etiology of which is obscure. The chronic inflammation and subependymal gliosis of the aqueductal region seen on neuropathologic examination raises the possibility that the retinal changes were due to a similar inflammatory process. Yet no inflammatory cells were seen in the retina, there was no fusion of choroid and retina and no proliferation or migration of the pigment epithelium.

The eyes of one other case of hydranencephaly are in our pathologic files but the case is not being reported in detail for lack of clinical data. Cross section of these eyes shows almost complete absence of ganglion cells, absence of any recognizable nerve fibers, and replacement of optic nerve by fibroglial proliferation. This case did not have the retinal gliosis which was such a prominent feature of our first case.

There have been four other cases, to our knowledge, in which the eyes have been studied pathologically.[14, 22] Of the three cases reported by Muir, none were studied ante mortem and in two of them the eyes at postmortem examination were said to be normal without further description. Their third case was described as having focal atrophy of the retina with absence of ganglion cells and thinning of the nuclear layers. No mention was made of the retinal vessels or of the presence or absence of gliosis. The case reported by Crome and Sylvester was described clinically as having a bilateral chorioretinitis with scattered discrete areas of pigmentation and large macular scars with similar areas of scarring elsewhere in the retina. The pupillary reaction to light was present but sluggish. Pathologically, there was widespread focal atrophy with loss of ganglion cells and cells of both nuclear layers. Proliferation of the pigment epithelium was considerable and confined mainly to the external layers of the retina although smaller collections of pigment were occasionally seen in the inner layers. Gliosis was not a prominent feature and no inflammatory reaction nor organisms were seen.

Although severe loss of ganglion cells and, to a lesser extent, bipolar cells was seen in all of the eyes in which histopathologic ab-

normalities were found, other pathologic features observed were not common to all of these eyes. It would appear likely, therefore, that these ocular changes may have different etiologies just as hydranencephaly itself may develop as a consequence of any of a number of pathologic processes.

Summary

The ocular signs associated with hydranencephaly are brought to the attention of the ophthalmologist and three cases in which ocular signs were prominent are presented. An interesting feature of these cases is the preservation of the optical blinking reflex which suggests that the pathways for this reflex are subcortical in these infants. A report of the ocular pathology of one of these cases (the second such clinicopathologic report in the literature) is presented as showing a noteworthy amount of gliosis in the inner retinal layers and a relative absence of the blood vessels.

243 Charles Street (14).

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We wish to express our appreciation to Dr. Toichiro Kuwabara for preparing the photomicrographs.

References

1. Cruveilhier, J.: Anatomie Pathologique du Corps Humain. Paris, J. B. Balliere, 1829-1835, v. 1, book 15, plate 4, pp. 1-2.
2. Bright, R.: Diseases of the brain and nervous system. In Reports of Medical Cases Selected with a View of Illustrating the Symptoms and Cure of Diseases by a Reference to Morbid Anatomy. London, Rees, Orme, Brown and Green, 1831, v. 2, case ccv, pp. 431-435.
3. Spielmeyer, W.: Ein Hydranencephales Zwillingspaar. Arch. f. Psychiat., **39**:807-819, 1905.
4. Norman, R. M.: In Greenfield, J. G., Blackwood, W., McMenemey, W. H., Meyer, A., and Norman, R. M.: Neuropathology. London, Edward Arnold Ltd., 1958, pp. 328-329.
5. Vogel, F. S., and McClenahan, J. L.: Anomalies of major cerebral arteries associated with congenital malformations of the brain: With special reference to the pathogenesis of anencephaly. Am. J. Path., **28**:701-711, 1952.
6. Marburg, O., and Casamajor, L.: Phlebostasis and phlebothrombosis of the brain in the newborn and in early childhood. AMA Arch. Neurol. & Psychiat., **52**:170-188, 1944.
7. Marburg, O., Rezek, P. R., and Marks, M. B.: Porencephaly II: Studies in phlebothrombosis and phlebostasis. J. Neuropath. & Exper. Neurol., **4**:43-58, 1945.
8. Yakovlev, P. I., and Wadsworth, R. C.: Schizencephalies: A study of the congenital clefts in the cerebral mantle: I. Clefts with fused lips. J. Neuropath. & Exper. Neurol., **5**:116-130, 1946.
9. ———: Schizencephalies: A study of the congenital clefts in the cerebral mantle: II. Clefts with hydrocephalus and lips separated. J. Neuropath. & Exper. Neurol., **5**:169-206, 1946.
10. Yakovlev, P. I.: Pathoarchitectonic studies of cerebral malformations. J. Neuropath. & Exper. Neurol., **18**:22-55, 1959.
11. Cohn, R., and Neumann, M. H.: Porencephaly: A clinicopathologic study. J. Neuropath. & Exper. Neurol., **5**:257-270, 1946.
12. Edinger, L., and Fischer, B.: Ein Mensch ohne Grosshirn. Arch. f. Physiol., **152**:535, 1913.
13. Bettinger, H. F.: Hydranencephaly. M. J. Australia, **2**:375-377, 1940.
14. Muir, C. S.: Hydranencephaly and allied disorders. Arch. Dis. Child., **34**:231-246, 1959.
15. Thelander, H. E., Shaw, E. B., and Piel, J. J.: Angiography in a case of hydranencephaly. J. Pediat., **42**:680-686, 1953.
16. Watson, E. H.: Hydranencephaly. AMA Am. J. Dis. Child., **67**:282-287, 1944.
17. McElfresh, A. C., and Arey, J. B.: Generalized cytomegalic inclusion disease. J. Pediat., **51**:146-156, 1957.
18. Hamby, W. B., Krauss, R. F., and Beswick, W. F.: Hydranencephaly: Clinical diagnosis. Pediatrics, **6**:371-383, 1950.
19. Alexander, E., Jr., Davis, C. H., Jr., and Kitahata, L. M.: Hydranencephaly: Observations on transillumination of the head of infants. AMA Arch. Neurol. & Psychiat., **76**:578-584, 1956.
20. Dodge, P. R.: Unpublished observations.
21. Dandy, W. C.: Diagnosis and treatment of strictures of the aqueduct of Sylvius (causing hydrocephalus). AMA Arch. Surg., **51**:1-4, 1945.
22. Crome, L., and Sylvester, P. E.: Hydranencephaly (hydrencephaly). Arch. Dis. Child., **35**:235-245, 1958.
23. Johnson, E. E., Warner, M., and Simonds, J. P.: Total absence of the cerebral hemispheres. J. Pediat., **38**:69-79, 1951.

24. Haler, D.: Specimen from a case of absence of cerebral hemispheres in which the infant survived for two weeks. Proc. Roy. Soc. Med., **28**:1075-76, 1934-35.
25. Casamajor, L.: A child without a forebrain. Tr. Am. Neurol. A., **63**:64-67, 1937.
26. Johnson, F. E.: Injury of the child by roentgen ray during pregnancy. J. Pediat., **13**:894-901, 1938.
27. Picaza, J. A., Cardelle, G., and Jiminez, R. M.: Hydroencephalodysplasia. J. Neurosurg., **12**:535-549, 1955.
28. Duke-Elder, W. S.: Textbook of Ophthalmology. St. Louis, Mosby, 1932, v. 1.
29. Walsh, F.: Clinical Neuroophthalmology. Baltimore, Williams & Wilkins, 1957, ed. 2.
30. Poser, C. M., Walsh, F. C., and Scheinberg, L. C.: Hydranencephaly. Neurology, **5**:284-289, 1955.

HEREDITARY FLECK DYSTROPHY OF THE CORNEA*

BARBARA WIARD STREETEN, M.D., AND HAROLD F. FALLS, M.D.
Ann Arbor, Michigan

The routine use of the biomicroscope is both revealing and rewarding. The detection of minute and, in many instances, unsuspected aberrations of the anterior ocular segment is the reward for a moment or two of careful scrutiny of each patient. Investigation of these subclinical defects should throw much light on the pathologic physiology of the eye. They would be especially advantageous to study because their primary pathology is not obscured by the extensive secondary degenerations found in more gross lesions.

During the past few years, as a consequence of such routine biomicroscopy, three patients have been seen who appeared to have a previously undescribed type of corneal stromal dystrophy. Examination of the families of two of the patients revealed that the corneal changes were hereditary in origin, transmitted as an autosomal dominant, probably nonprogressive and congenital.

In reviewing the literature, it was found that François and Neetens, [1,3] and François[2] had recently reported two families exhibiting corneal opacities apparently identical with those observed in our cases. These authors called this condition "hérédo-dystrophie mouchetée," which seems most aptly translated as hereditary fleck dystrophy. The following cases are presented in order to promote wider familiarity with this benign entity, and its differentiation from the better known progessive corneal dystrophies.

* From the Department of Ophthalmic Surgery, University of Michigan Medical School.

CASE REPORTS

CASE 1

S. H., an 18-year-old white woman, a student, was seen at the University Health Service on March 18, 1957, complaining of a decrease in distant vision, which had been noted for three months. Her past medical and ocular history was noncontributory.

Ophthalmologic examination. The visual acuity was 20/40—2, right eye; 20/30—1, left eye. The cycloplegic refraction disclosed —1.0D. sph. ⊂ 0.25D. cyl. ax. 18°, right eye, —0.75D. sph. ⊂ 0.25D. cyl. ax. 140° left eye, giving a corrected visual acuity of 20/15—1 in each eye. External examination findings and the extraocular motility were within normal limits. The corneas grossly appeared perfectly clear. The fundi were normal blonde in type. Biomicroscopic study revealed throughout both corneas small, discrete flecks, dots and circular opacities which were scattered randomly and profusely at all levels of the stroma, with the exception of Bowman's and Descemet's membranes. They were grayish to gray-white, with a density not much greater than that of the stroma so that it was difficult at first to appreciate the large number of opacities present. Besides having diversity of form, the opacities were variable in size and in degree of opaqueness. The most typical lesion was a wreath-like circle or oval, complete or interrupted. Some of these were large enough to be clearly seen in detail under low power. Others, which appeared under low power as irregular flecks, had transparent centers under high power and were thus variants of the above-described circular pattern. Many, however, were homogeneous flecks or dots even with high-power magnification. The opacities had very little antero-posterior thickness, being flat or platelike in optical section. None was present in the immediate Bowman's or Descemet's membrane zones. They were evenly distributed in all areas of the corneal stroma, extending to the periphery. The intervening stroma was entirely normal, as were the epithelium

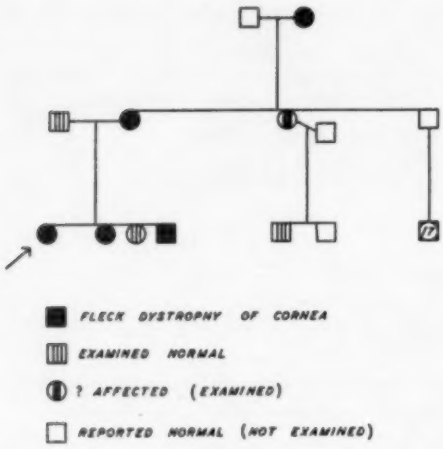

Fig. 1 (Streeten and Falls). Hereditary fleck dystrophy of the cornea. Pedigree of Case 1.

and endothelium. No relation to the corneal nerve distribution was evident, and corneal sensation was intact.

All available members of the family were examined either in the clinic or in their homes with a Poser slitlamp. Only the patients with pathologic corneal findings will be described. All had 20/20 or better visual acuity unaided or with correction, except as noted. The pedigree appears in Figure 1.

M. H., aged 44 years, mother of the proband, had corneal opacities identical in character with those of her daughter. Some may have been larger than those in the latter's corneas, but it was difficult to be sure of any real difference.

J. H., a girl aged 13 years, had opacities in both corneas identical in morphology and distribution with those seen in her sister's eyes.

H. H., a boy aged four years, also had corneal changes matching those of his sister, S. H.

J. L., aged 51 years, maternal aunt of the proband, showed four flecklike dots in the central cornea, right eye, at different stromal levels, but no typical wreaths were seen. The left eye was completely clear. She was also myopic.

M. S., aged 82 years, maternal grandmother of the proband, had had repeated retinal and vitreous hemorrhages in the left eye, secondary to hypertensive and arteriosclerotic vascular disease but otherwise had no history of ocular disease. Wearing a hyperopic correction, she had a near visual acuity at 33 cm. J1, right eye, and Lebensohn 20/800, left eye. Ophthalmoscopic examination showed grade 2 (K.C.W.) hypertensive arteriosclerotic vascular changes in the right eye, and in the left eye, large vitreous opacities, macular gliosis, with extensive hard white "exudates" in the perimacular area. Slitlamp examination revealed the characteristic corneal lesions. There were two opacities in the central anterior corneal stroma of the right eye which were larger and more opaque than any of those in her progeny. There was considerable endothelial dusting, bilaterally, which seemed to make all of the lesions easier to discern in reflected light. The endothelium itself showed only a few guttate changes.

CASE 2

W. T. J., a 28-year-old graduate student, was seen on October 28, 1957, at the University Health Service for ophthalmoscopic examination, during an investigation for chronic glomerulonephritis. His only symptoms had been pedal edema for several months, two years before. The blood pressure had never been elevated, but he had two-to-four-plus albuminuria consistently, with occasional cylinduria. The ocular history was negative.

Ophthalmologic examination. The visual acuity was 20/20—1, right eye, and 20/20—2, left eye. Cycloplegic refraction was —0.5D. sph. ⊃ 0.37D. cyl. ax. 6°, right eye; —0.5D. sph. ⊃ 0.75D. cyl. ax. 130°, left eye, giving a corrected visual acuity of 20/15—1 in each eye. External examination and extraocular motility revealed no abnormalities. The ophthalmoscopic examination showed small perifoveal drusen in both eyes. Slitlamp examination disclosed corneal opacities which were very similar to those observed in the preceding family, save that the opacities in the deeper layers tended to be larger than those more anteriorly. Under high-power magnification the largest forms, a few just above Descemet's membrane, were seen to be two wreathlike forms joined together. Figure 2 is a drawing of the right cornea as seen in the slitlamp.

The patient's parents were examined but the only sibling, a man aged 35 years, was not available. The father, aged 63 years, had lesions very similar to

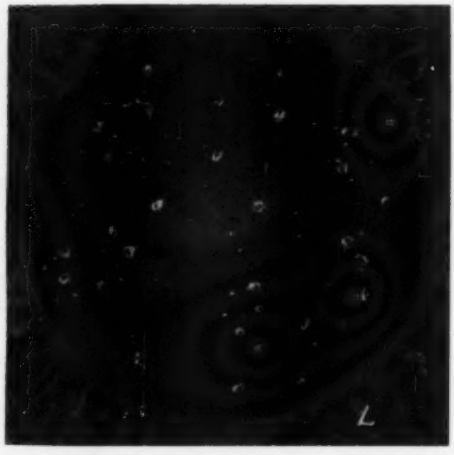

Fig. 2 (Streeten and Falls). Hereditary fleck dystrophy of the cornea. Drawing of the opacities as seen in the central cornea of Case 2, under low power.

those of his son, with good visual acuity and no ocular complaints.

Discussion

There seems no doubt that these cases are examples of "hérédo-dystrophie mouchetée," as reported by François and Neetens, and their excellent clinical description cannot be improved upon. The characteristic features of this condition are the purely stromal distribution of small opacities, their variability in shape and size, and the lack of preference for any particular region or level of the corneal stroma. The form which appears to us to be most predominant is a wreathlike circle, complete or incomplete. No abnormality of the stroma between these very discrete opacities is seen. The dystrophy produces no symptoms, does not interfere with vision or affect corneal sensation. Inheritance, where ascertainable, has shown autosomal dominance in all reported cases.

François and Neetens state that the corneal changes are bilaterally identical. This is difficult to assess when the number of opacities is great, but in our patients who exhibited a few larger forms it could be seen that these, at least, were not symmetrical. With the exception of one questionable case, all of our patients had large numbers of opacities. Figure 2 illustrates a quite representative distribution, showing about 30 opacities in the pupillary area with an undilated pupil. Out of 31 affected members in François and Neetens' larger family, 14 had apparently many fewer opacities than this, even as few as four or five in an entire cornea. Our questionable case showed four flecks in one cornea, none wreathlike, and no flecks in the other cornea. Without evidence that she has transmitted the trait, it cannot be said that these monocular flecks are due to this disease. It is not surprising, however, that in a genetically determined condition such as this there should be a variability in expressivity of the defect.

An important feature not mentioned in the previous reports is the very subtle nature of these corneal opacities. In a casual slitlamp examination, such as a normal young person with excellent vision might receive, only one or two of the more opaque nebulae, especially on the nasal side, might catch the eye. This is due to the fact that the opacities are best seen in reflected light, and only with a good sclerotic scatter is it appreciated that the cornea is full of small opacities. Thus the drawing of an optical section in the aforementioned references exaggerates both the size and visibility of the flecks, as could be guessed from their nebulous appearance in the accompanying high-power drawing.

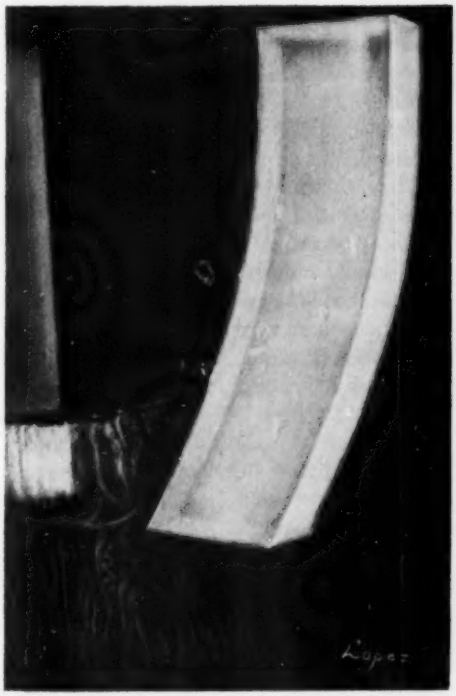

Fig. 3 (Streeten and Falls). Optical section shows the level of the opacities, under high power.

The important question of progression of the dystrophy is difficult to answer in any horizontal study, since some slow progression either in number or size of the opacities might occur in an individual patient. This would be obscured in a large series because of variability of involvement in different in-

dividuals at the onset. However, in our youngest patient, aged four years, there was no significant difference in the number of corneal opacities from that in his grandmother, aged 82 years. She did have two larger and more opaque forms in one eye, but similar ones were seen in Case 2, aged 28 years. François and Neetens report fully developed cases in patients aged two and three years, and state without qualification that the condition is not progressive. The evidence is thus entirely against progression, and supports the possibility that the lesions are congenital.

In the fully developed case, there can be no confusion with known corneal dystrophies. The diffuse distribution of the opacities, their nebulous nature, and the absence of ocular symptoms are quite unique. Conceivably, if fewer forms were present so that the above characteristics were not readily apparent, the condition might resemble an *early* Groenouw's granular dystrophy, because of the similar morphology of the opacities in the two dystrophies. Observation would, of course, show that there was no characteristic progression of the flecks, no decrease in corneal sensation or vision, and no change in the epithelial surface. The correct diagnosis could be rapidly and expediently made by simply examining available relatives of the patient.

SUMMARY

Eight cases of hereditary fleck dystrophy of the cornea, as recently described by François and Neetens, are presented. Inheritance was found to follow an autosomal dominant pattern. The apparently nonprogressive, asymptomatic nature of this bilateral condition, together with the distinctive appearance and distribution of the stromal opacities, differentiate it easily from the known corneal dystrophies. The difficulty in appreciating the diffuse distribution of the flecks without careful slitlamp examination is emphasized.

University Hospital.

REFERENCES

1. François, J., and Neetens, A.: Nouvelle dystrophie hérédofamiliale du parenchyme cornéen (Hérédo-dystrophie mouchetée). Bull. Soc. Belge ophtal., **114**:641-646, 1957.
2. François, J.: Nouvelles dystrophies hérédo-familiales de la cornée. Bull. Acade. Royale Méd. Belgique, **22**:147-155, 1957.
3. François, J., and Neetens, A.: L'hérédo-dystrophie mouchetée du parenchyme cornéen. Acta Geneticae Med. & Gemellologiae, **6**:387-392 (July) 1957.

THE FINE STRUCTURE OF THE CORNEAL EPITHELIUM AND BASEMENT MEMBRANE OF THE RABBIT*

C. C. TENG, M.D.
New York

The fine structure of the cornea has been studied by Sebruyns (1950), Van den Hooff (1952), Schwarz (1953), and Jakus (1954). Most of the investigators concentrated on the collagen structure of the cornea, except for Jakus, who is studying all the corneal structures and has presented excellent reports on the collagen and on Descemet's membrane.

Sheldon, in 1956, reported on the epithelium of the cornea of the mouse, and Ishida, in 1958, studied corneal epithelium.

In this communication we are primarily interested in the basement membrane of the corneal epithelium which we reported in 1953, basing our reports on studies using light microscopy. Our report on the base-

* From the Laboratory of The Eye-Bank for Sight Restoration, Inc., Manhattan Eye, Ear and Throat Hospital. This study was aided by a grant from the William and Mary Greve Foundation, and by grant B-2623 of the U.S. Public Health Service.

ment membrane has since been confirmed by Jakus, Sheldon, and Ishida in their electron microscope work.

Recently we found that with two new stains, Watson's lead hydroxide and uranyl acetate, we could bring out the general picture of the corneal tissue under electron microscopy much better than was possible before. This report, therefore, includes a general picture of the epithelium, together with a description of a new finding—a unicellular, glandular type of epithelial cell. Observations as to the relationship of this cell to the basement membrane will also be presented.

Materials and Methods

The rabbit cornea was chosen for this study, since it is the most commonly used and widely reported experimental material in ophthalmology. Young rabbits about two months of age were used. The rabbits were anesthetized with intravenous injection of Nembutal. When the rabbit was well anesthetized, the cornea was removed with a trephine, fixed in one-percent osmium tetroxide in veronal acetate buffer (pH 7.4 to 7.6) for one hour, then dehydrated through a series of ethyl alcohol solutions, according to Palade's routine.

The tissue was then cut in small pieces, about 1.0 by 1.0 mm. and embedded in n-butyl methacrylate. The embedded tissue was sectioned with the Porter-Blum microtome. Satir and Peachey's method using xylol vapor was found to be very useful in flattening the sections. Watson's lead stain and uranyl stain were routely used and were very valuable. The electron microscope used was the EMU-3.

Observations

Epithelium of the cornea (figs. 1-9)

It is a well-known fact that under normal physiologic conditions epithelial cells die continuously and are shed from the superficial layer. The cells in the basal layer are columnar in shape, and as these cells are pushed forward by new cells, their shapes become flatter and flatter. At the same time the cells are degenerating and disintegrating until the last stage when they are shed.

The three stages or types of cells are described according to their site—the basal cell at the posterior layer, the wing-shaped cell in the middle and the squamous cell in the superficial layer.

Under electron microscopy the cytoplasm of the basal cells appears more granular, while in the wing cell it becomes fibrillar, due to the increase of tonofibrils in the cytoplasm. This fibrillar change may also involve the nucleus in the later stages. Toward the superficial layer all the organelles, the nucleus, the desmosomes and the cell membrane are gradually broken into small, irregular fragments prior to desquamation. The cell membrane tends to form folds toward the superficial layer, and it can sometimes be very irregular. For instance, one may find a great accumulation of desmosomes in the folds (fig. 4).

The nucleus

The nuclei of the epithelial cells in the basal layer are usually round or oval in shape, situated in the anterior portion of the cell, and they usually contain one or two massed, dense nucleoli. The nuclear membrane is distinctly double and occasionally pores can be demonstrated. The nuclei of the wing cells shift to the center of the cell. They are flatter and arranged parallel with the surface of the cornea. As the cells are pushed forward toward the outer layer there is a gradual increase of tonofibrils in both the cytoplasm and nucleus. In a still later stage the nuclear membrane becomes irregular and breaks up with further increase of tonofibrils (fig. 5). The nucleus usually disintegrates before the cell is shed at the surface of the cornea.

The mitochondria

The mitochondria of the corneal epithelial cell is composed of irregular, slender filaments. These filaments are usually only re-

vealed in cross section. They are mostly at the posterior portion of the basal cell and around the nucleus. The cristae of mitochondria are irregular, laminated, tubular or like microvilli in form. The number of mitochondria changes, possibly due to the cellular activity. Intramitochondrial granules are sometimes found.

Vacuolation is often found in the mitochondria (fig. 7). Sometimes the vacuoles are found between the external and internal limiting membranes of the mitochondria and sometimes they are found within the cristae. This morphologic difference may represent differences in the physiologic states of function, as suggested by Lever and Chappell in their report of a study of the mitochondria of liver cells and brown adipose tissue of the rat.

The endoplasmic reticulum

In the basal cells of the corneal epithelium the endoplasmic reticulum is composed of ill-defined vesicles and tubules forming a continuous network of membrane-bound cavities. They are usually rough in profile with deposition of Palade's particles or microsomes, and there are many similar microsomes free in the cytoplasm.

The Golgi complex (figs. 6 and 9)

The Golgi complex is usually found in the distal end of the cell at the apex of the nucleus. Occasionally small parts may be found close to the side of the nucleus. Typically it is an array of elongated, smooth-surfaced profiles surrounded by circular or oval profiles. The Golgi complex is usually closely associated with the endoplasmic reticulum. In general they look very well developed.

Desmosomes (intercellular bridges, terminal bars or nodes of Bizzorero) (figs. 4, 15, 16 and 17)

In the corneal epithelium the desmosomes are numerous and well developed between both types of epithelial cells, that is, both the ordinary epithelial cell and the secretory type of epithelial cell described later in this report. The number of desmosomes increases toward the superficial layers of the cornea. Foreign cells, such as white blood cells, when found in this area, do not form these intercellular bridges with the epithelial cells.

In the basal cell layer of the epithelium desmosomes are seen in a localized area of opposing cell membranes. Each side consists of a thickened area with a collection of dense material. In each cell bundles of tonofibrils approach the dense membranes, but the fibrils usually do not appear to cross over from one cell to the other. There is also dense material found between the two thickened membranes. Usually this is granular material, but occasionally it may be in a fibrous form.

In the wing cells the desmosomes become more fibrous and fibers from one cell appear to pass through the intercellular space into the other epithelial cell. The fibers look similar to the tonofibrils found within the cell.

Besides the desmosomes often there are numerous fine intercellular fibers (tonofibrils) which cross the intercellular spaces at irregular intervals.

As the epithelial cells are displaced toward the superficial layer they disintegrate into fine granules before they are shed. The desmosomes and intercellular fibers also change in this way, breaking up into small granules. Often the change seems to appear earlier in

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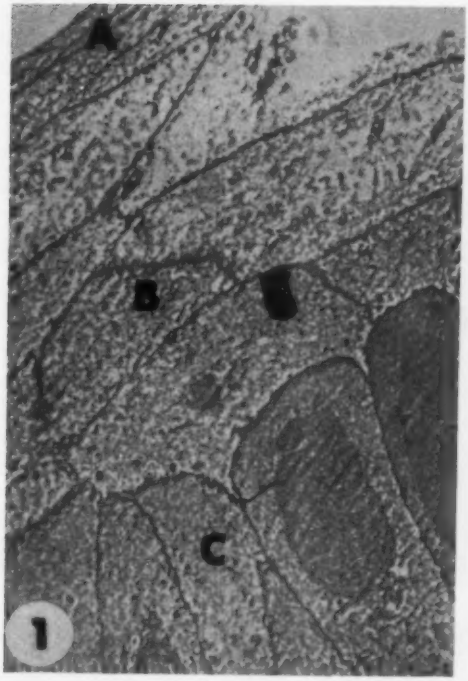
Fig. 1 (Teng). Cross section of rabbit corneal epithelium. (A) Superficial layer, squamous cells. (B) Middle layer, wing cells. (C) Posterior layer, basal cells. (×3,000.)

Fig. 2 (Teng). Cross section of basal layer of epithelium. (E) Ordinary epithelial cell. (S) Secretory epithelial cell. (BM) Basement membrane. (St) Stroma. (×3,000.)

Fig. 3 (Teng). Oblique section of the superficial layer of epithelium. Shows degeneration of cells with disintegration of nucleus and organelles, and disappearance of most of the tonofibrils. (N) Nucleus. (A) Anterior surface of cornea. (×3,800.)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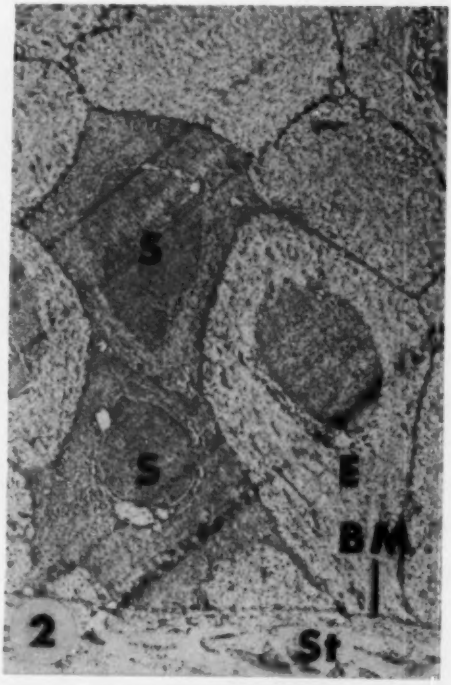
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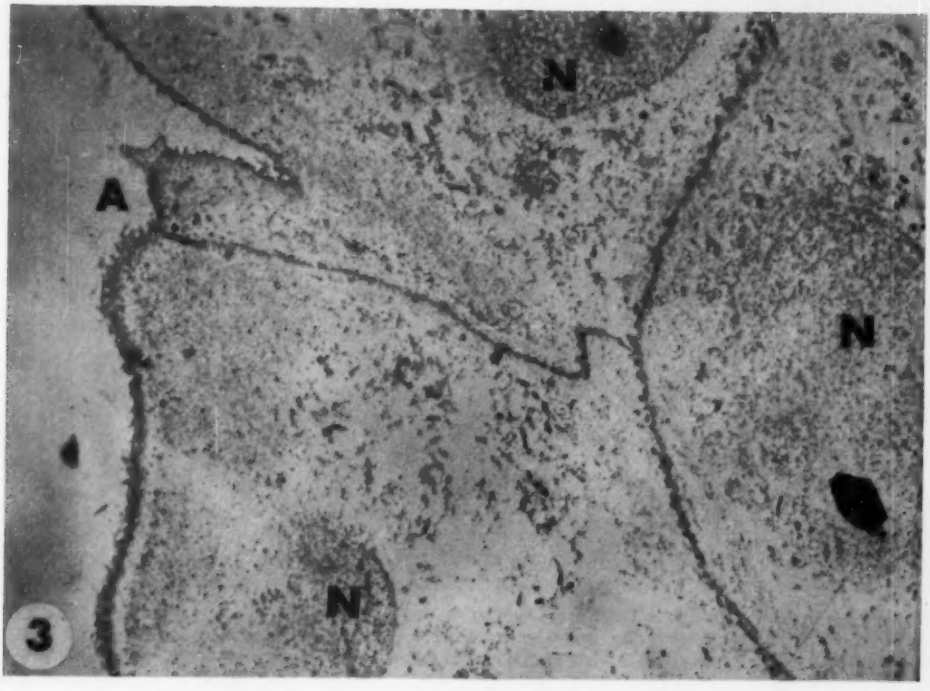
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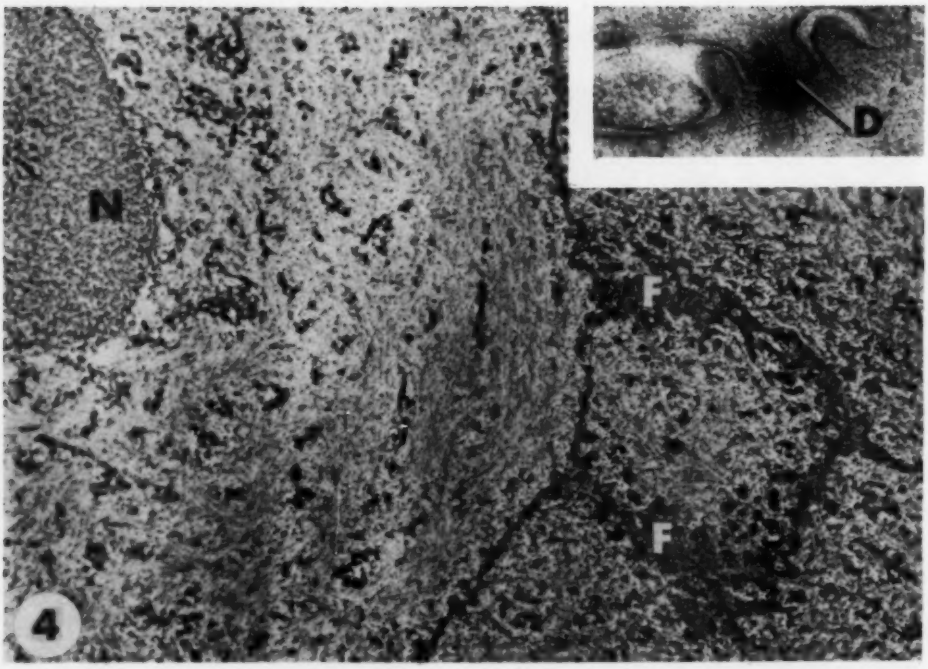


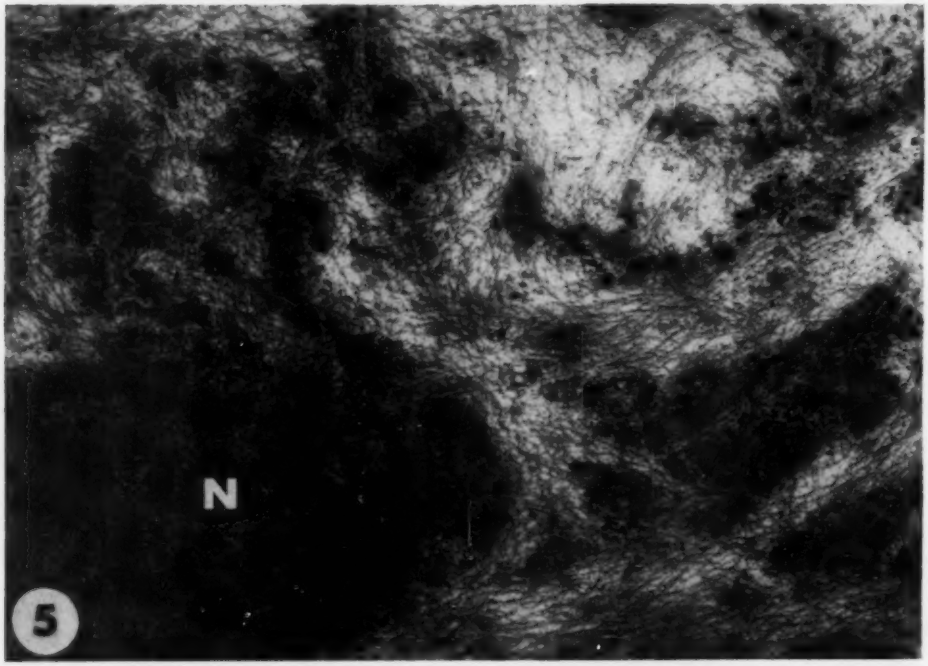
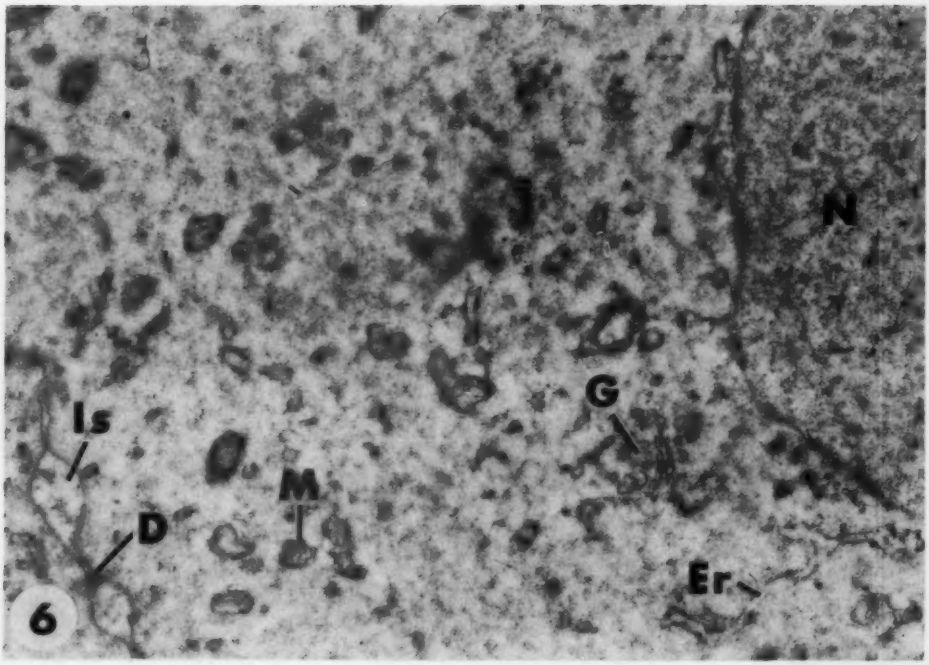


Fig. 4 (Teng). Wing cells of middle layer of epithelium, in oblique section. (N) Nucleus. (F) Foldings of cell membrane. There is a general increase of tonofibrils in the cytoplasm. (×7,000.) INSERT: Foldings of cell membrane and a desmosome (×50,000).

Fig. 5. (Teng). Increase of tonofibrils; disintegration of nuclear membrane due to invasion of tonofibrils into the nucleus (N). Later stage than Figure 4. (×31,000.)



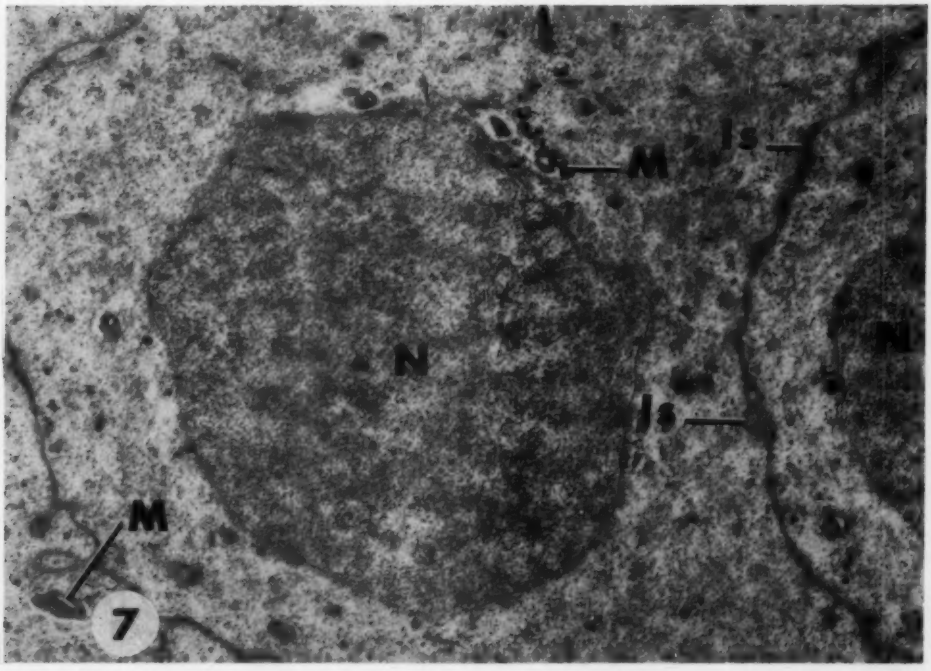
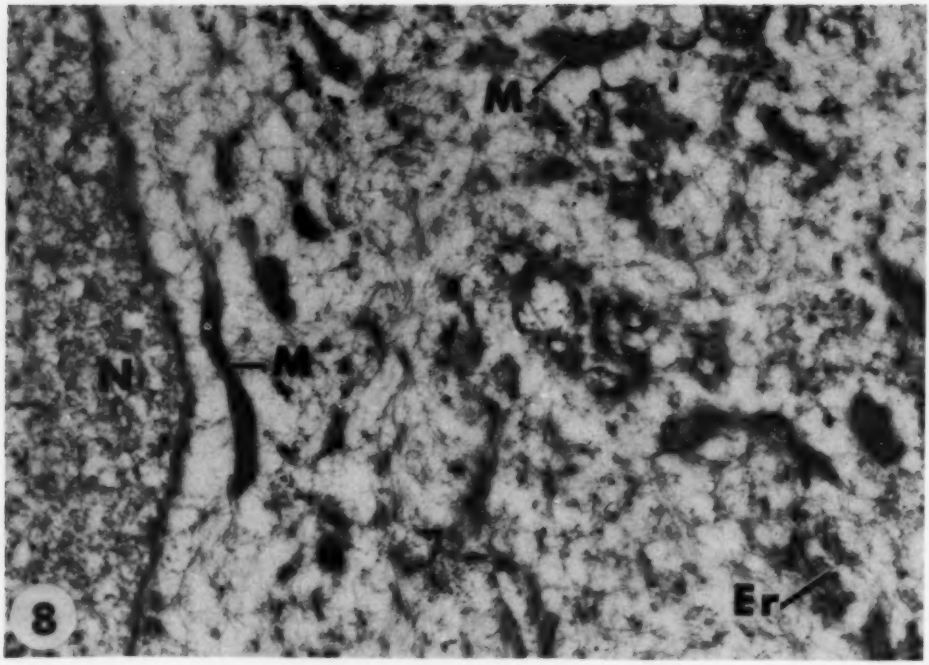


Fig. 6 (Teng). Epithelial cell in basal layer. Note general granular appearance. (N) Nucleus with double-layered nuclear membrane. (M) Mitochondria. (Er) Endoplasmic reticulum. (G) Golgi complex. (D) Desmosome (terminal bar). (Is) Intercellular space with some granular substance (transient secretory capillary). (×21,000.)

Fig. 7 (Teng). Similar to cell in Figure 6 except mitochondria (M) here has vacuoles and intercellular space (Is) has more granular secretory material. (×17,000.)



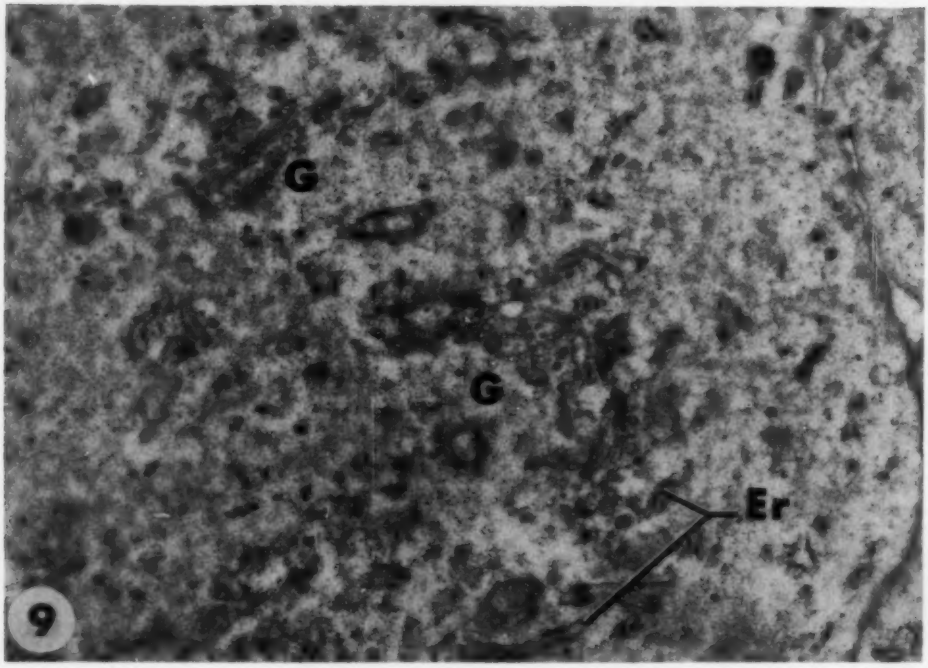


Fig. 8 (Teng). Moderate increase of tonofibrils shown in a wing cell. Shows relationship of tonofibrils to nucleus and all organelles. (N) Nucleus. (M) Mitochondria. (Er) Endoplasmic reticulum. (×32,000.)

Fig. 9 (Teng). Oblique section of apex region of basal layer of epithelial cell. Shows well-developed Golgi complexes (G) and their close association with the endoplasmic reticulum (Er). (×22,000.)

the intercellular spaces than in the cell wall and intracellular structures.

Both the desmosomes and the fine intercellular fibers are well demonstrated in the rabbit corneal epithelium and even better presented in human corneal epithelium (figs. 15, 16 and 17).

Secretory epithelial cells of cornea

According to our morphologic study, besides the ordinary epithelial cells there is another type of epithelial cell characterized by its secretory function, and closely associated with the basement membrane. It occurs very infrequently—only three times in the 50 blocks of 10 rabbit corneas we have sectioned.

The shape of this cell varies (figs. 2, 10 through 13). It is columnar in the basal layer and changes form like the ordinary epithelial cells as they are pushed toward the superficial layer. They also disintegrate similarly to the ordinary epithelial cell, but more slowly. These secretory cells, however, often look irregular, with irregular processes extending out between the cells in a rather starlike shape. Although the secretory cells are more irregularly shaped than other epithelial cells, they are still fixed in place by desmosomes connecting with other epithelial cells.

This type of cell is much more osmophilic than ordinary epithelial cells. Histologically it stains deeply with periodic acid Schiff reagent. It is also more basophilic, staining deeper in hematoxylin than other epithelial cells. The nucleus also stains deeper, but its shape is the same as that of other epithelial cell nuclei. Under electron microscopy the cytoplasm and nucleus are seen to be packed with very dense particles. Some of these particles are coarse (about 15 mμ) and osmophilic; others are finer (about 5.0 mμ) and less osmophilic. The increased density of the cytoplasm of the cell is chiefly due to the presence of these compact, osmophilic particles. The number varies. Sometimes they are so dense that we are unable to make out any of the organelles, and other times the organelles can be distinguished to a limited degree. This may possibly be due to the different stages of secretory activity of the cell.

The relationship of these particles to the endoplasmic reticulum shows that the reticulum is much better developed in this secretory type of cell. The cytoplasm is filled with dense particles attached to the profiles of the endoplasmic reticulum and there are abundant free particles in the cytoplasm.

The Golgi apparatus (fig. 10 insert) is similar in appearance to that of the ordinary epithelial cell, except that it usually has more vacuoles and the mitochondria appear the same in both types of cells.

The most interesting feature of this type of epithelial cell is its secretory activity. It sends out irregular processes which push into the intercellular spaces. The cell processes stop at some distance, but material from the cytoplasm and the two types of secretory granules are found further on in the spaces between the cell membranes of other epithelial cells. In this respect they seem to be a transient "secretory capillary." These capillaries follow very winding courses, passing through the desmosomes and intercellular fibers toward the level of the basement membrane of the epithelium. The degree of concentration of these secretory particles may vary with the stages of secretion. Finally the secretory particles seem to collect between the cell membrane and the reticular fiber meshwork of the basement membrane.

Occasionally some larger constituents of cytoplasm may be found in the intercellular space with the other particles. This may mean that when the cell discharged the secretory material the cell membrane was broken. This description may fit the apocrine type of secretory cell, a unicellular gland, such as the goblet cell of the conjunctiva.

Basement membrane

Our light microscope study of the basement membrane of the corneal epithelium showed that it stained deeply with periodic acid-Schiff reagent. It also stains with Sudan

IV, osmic acid and the Feulgen reaction. The fact that it takes this last stain shows that the basement membrane contains a phospholipid, plasmalogen, which Friedenwald and Buschke demonstrated was important to wound healing. Using Wilder's silver stain we can demonstrate the presence of a network of reticular fibers in the basement membrane. We also have the impression that the plasmalogen is situated in the superficial layer and muco- or glycoprotein collects in the reticular fiber meshwork.

Under electron microscopy (figs. 11, 13 and 14) it is apparent that the basement membrane may be divided into two layers. The superficial layer consists of a thin osmophilic or lipid layer and this is backed by a thicker posterior layer made up of reticular fiber meshwork.

The osmophilic or lipid layer is adherent to the cell membrane. Judging from the density of stain and the granular appearance it is made up of the same sort of coarse particles (15 mμ) found in the secretory capillaries and secretory epithelial cells. This layer usually changes into a uniform, homogeneous sheet, without any granular appearance. This is probably the lipid layer.

In the rabbit cornea the reticular fiber meshwork behind this lipid layer may be further divided into three layers, all made of reticular fibers, but of varying densities. First comes a superficial layer of very fine meshwork, then a coarser meshwork with many large holes which, in cross section, look like irregular bridges. In lower magnification it looks like a clear line of space. The third and last layer of reticular meshwork is thicker than the superficial first layer and finer in structure than the middle layer. The finer, less osmophilic (5.0 mμ) particles or granules collect in this reticular fiber layer.

The appearance of the reticular fibers is the same in all layers. The collagen fibers behind the reticular meshwork appear to be a young form of collagen. The reticular fibers and the collagen fibers may be mingled at the point of contact between the two surfaces, but there is no direct continuation between the two systems. The reticular fiber is about 0.25 to 0.20 of the thickness of collagen fibers.

Tonofibrils and the reticular fibers

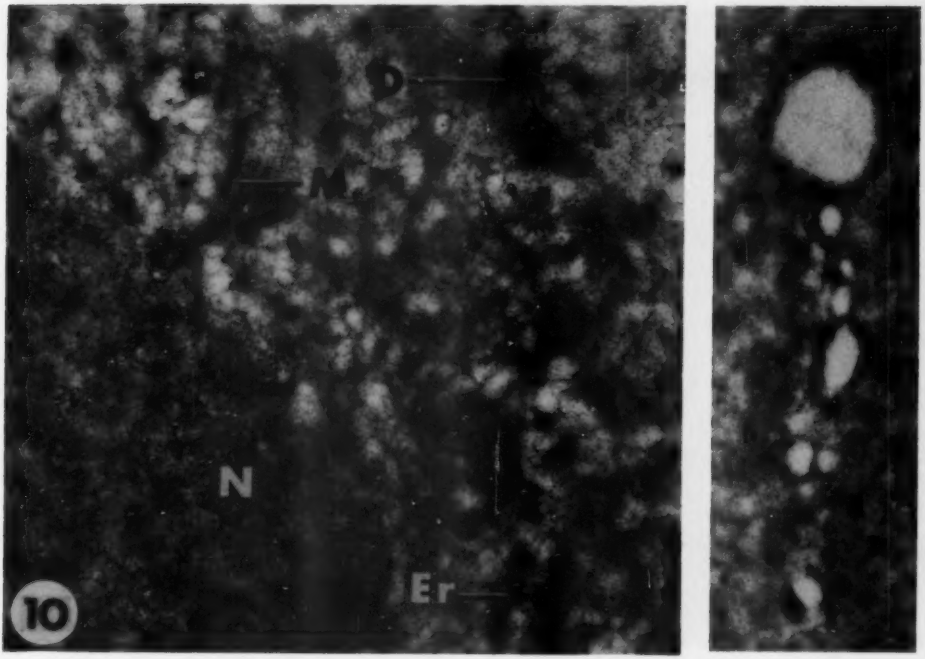
The tonofibrils of the epithelium seem to pass through the plasmic membrane into the basement membrane where they are continuous with the reticular fibers, looking very much the same in thickness and pattern.

Discussion

Tonofibril formation and change. The appearance and quantity of tonofibrils in corneal epithelial cells change as the cells change in the various layers of the epithelium. In the basal layer there are usually very few tonofibrils and the cytoplasm appears to be granular; in the middle layer tonofibril formation is extensive and in the outer layer the filaments gradually disintegrate as the cells push toward the superficial layers. By the time the cell is ready to be shed, the filaments have been reduced to fine, irregular granules.

Fig. 10 (Teng). Secretory epithelial cell. Compare with ordinary epithelial cell in upper right corner. The secretory epithelial cell often has even more dense particles than this, making it hard to distinguish the structure in detail. Note the increase of endoplasmic reticulum (Er), the dense particles attached to them, and the numerous free particles around them. The nucleus (N) also looks dense, being full of dense particles. There is some increase of tonofibrils in the cytoplasm; the mitochondria is not distinct; the desmosomes (D) are normal in appearance. (×31,000.) Insert: The structure of the Golgi complex shown here in the secretory cell is not as distinct as that seen in the ordinary epithelial cell because it is packed with dense particles. There are also more vacuoles. (×32,000.)

Fig. 11 (Teng). General view of a secretory epithelial cell showing its relationship to the basement membrane. (S) Secretory epithelial cell. (Is) Intercellular spaces which act as transient secretory capillaries leading toward the basement membrane. (BM) Basement membrane. (St) Stroma. (×8,400.)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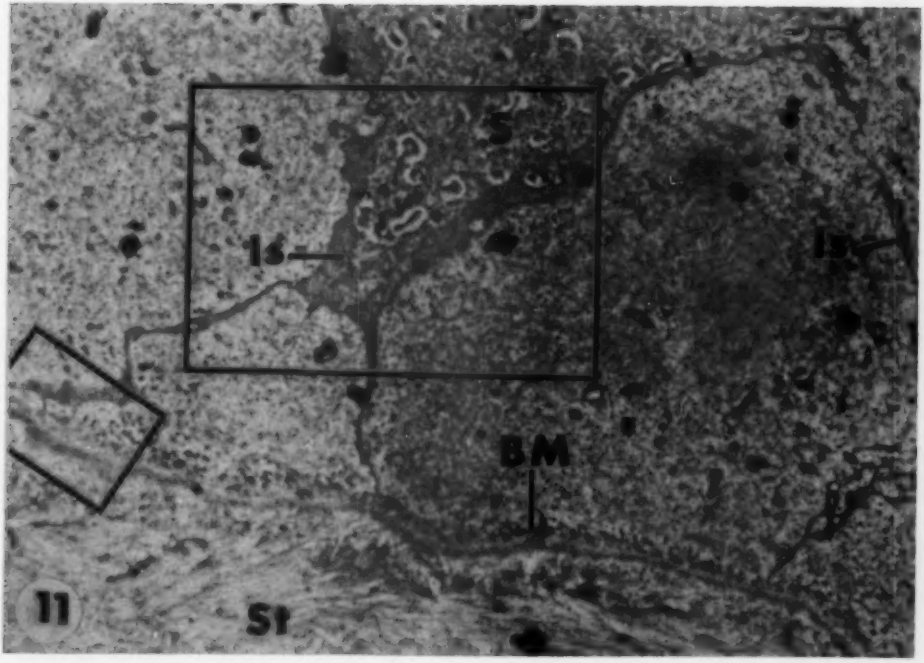
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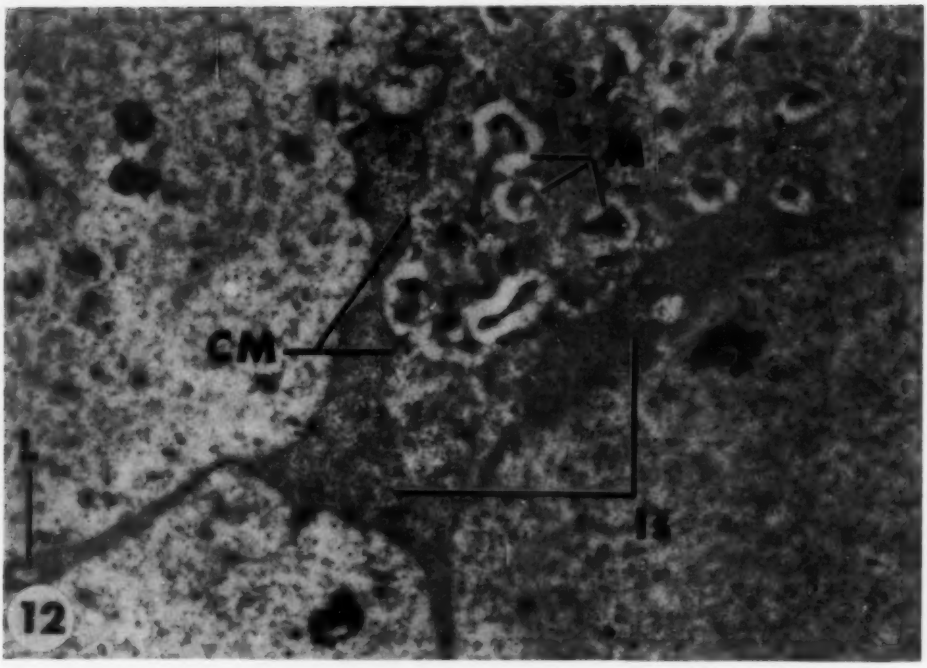
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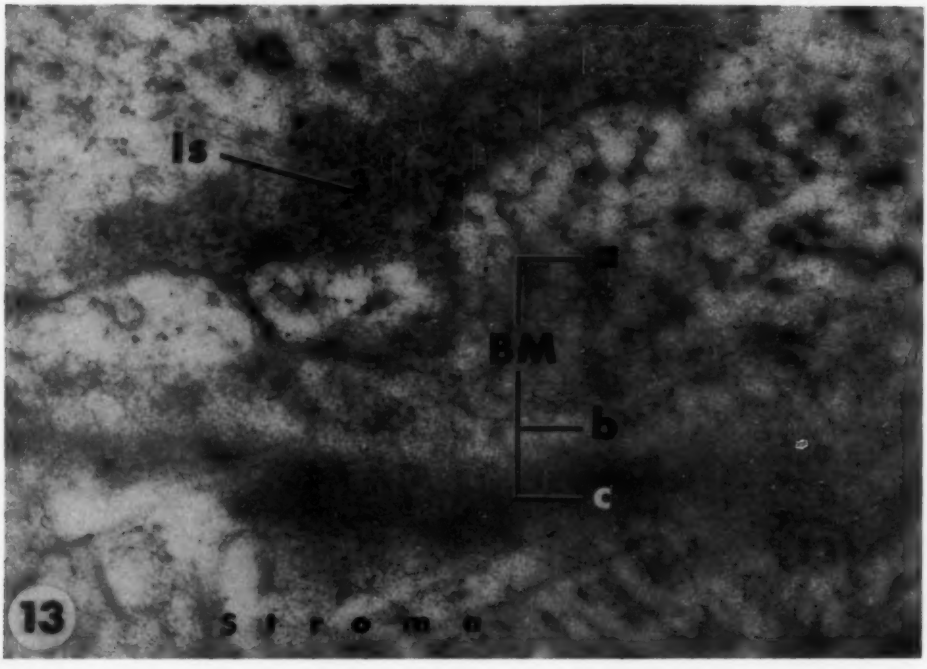
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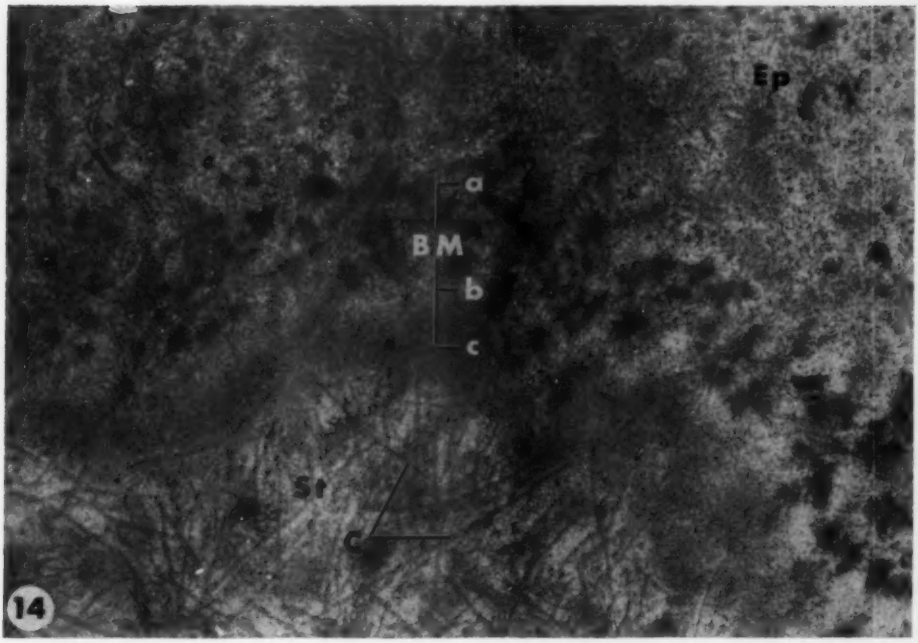

Fig. 14 (Teng). (BM) Basement membrane of epithelium: (a) anterior layer, (b) middle layer and (c) posterior layer of reticular meshwork. (Ep) Epithelial cell. (C) Collagen fibers. (St) Stroma. The 15 mμ particles are caught in front of the anterior layer of the reticular meshwork. The meshwork of the middle layer is much looser and looks like a clear line of empty space in low resolution, while the posterior layer has as fine or finer meshwork than the anterior layer, so that most of the smaller particles are caught in this layer. The stroma (St) is made up of young collagen fibers having no direct connection with the reticular fibers. (×44,000.)

The normal cornea, therefore, does not have the irregular, dandrufflike flakes of keratin such as are found in the skin. Physiologically this is an important factor in the transparency of the cornea. Whether this disintegration of the tonofibrils is due to some factor in the tears or to a lytic agent in the cell is a question worthy of further investigation. It seems likely that the tonofibrils of the corneal epithelium are similar to the tonofibrils of epidermal cells, which Porter and Selby believe are keratin precursors.

In the wing cells where the tonofibrils are most extensive they are found attached to all the organelles and intracellular structures.

Fig. 12 (Teng). Portion from Figure 11. (M) Mitochondria with vacuoles. (CM) Cell membrane of a secretory cell. (Is) Intercellular spaces with secretory particles. (L) Large constituents from cytoplasm in the intercellular space. (×20,000.)

Fig. 13 (Teng). Oblique section of specimen shown in Figure 11. (IS) Intercellular space or secretory capillary linked with the basment membrane (BM). Note large osmophilic particles (about 15 mμ) and smaller, less osmophilic particles (about 5.0 mμ) in the secretory capillary. The reticular meshwork of the basement membrane consists of three layers, (a) the anterior, (b) middle and (c) posterior layers. The reticular fibers are continuous with and similar in appearance to the tonofibrils of the epithelial cell. The large particles are found on the superficial layer of the basement membrane, probably a lipid layer, while smaller particles collect in the reticular fiber meshwork. (×64,000.)

The tonofibrils are found even in the cytoplasmic extrusion in the nucleus (Watson), having passed through the nuclear pores.

In these cells with abundant tonofibrils the mitochondria appears normal, well defined and well endowed with attached tonofibrils (fig. 8). At this stage of cellular life there may still be movement of the mitochondria, and this may help break up the nuclear membrane and other cellular components, including the mitochondria itself.

Desmosomes (terminal bars, intercellular bridges or nodes of Bizzorero). The morphology of desmosomes has been a subject for great controversy in the field of anatomy for years, and the voluminous literature has been reviewed repeatedly.

Using Watson's lead stain, we found that the structure of the desmosome in the wing cell of the corneal epithelium was demonstrated and our evidence seems to support the old theory of Ranvier that desmosomes are an extracellular prolongation of the intraepithelial fibrils (tonofibrils) which pass from one cell to another through the desmosomes.

Another theory was proposed by Porter and supported by Selby, Odland, Hibbs and Clark. Odland recently defined the nodes of Bizzorero as a pair of attached plaques, one from each of two contiguous epidermal cells, with seven intervening layers of different density, occupying the space, approximately 350 Angstroms in width, between opposed, attached plaques. Each plaque is a dense oval plate (0.3-0.7 μ in diameter and more than 100 Å in thickness). The plates appear to be greatly thickened modifications of the epidermal cell membrane and have lamellar structures of their own.

Intraepithelial fibrils (tonofibrils) approach the plaques from the interior of the cell. Their constituent filaments (tonofibrils) fray out and appear as cross-striations near their termination at the internal face of the attachment plaque.

Other investigators, including Fawcett and Selby, gave a simpler description. They thought that in squamous epithelium desmosomes are a local specialization of opposing cell surfaces, and thus have a bipartite structure. Each half consists of a thickened area of cell membrane with an accumulation of dense material in the subjacent cytoplasm. The two halves are separated by a narrow space 150-200 Å wide which usually appears empty under electron microscopy, but in life is probably occupied by an amorphous, intercellular substance of low density that is not preserved by osmium fixation. Hibbs and Clark demonstrated this extracellular desmosomal material.

Our specimens, however, demonstrate that the tonofibrils pass from one cell to another at the desmosome, and this is the main point of argument in the two theories. We were

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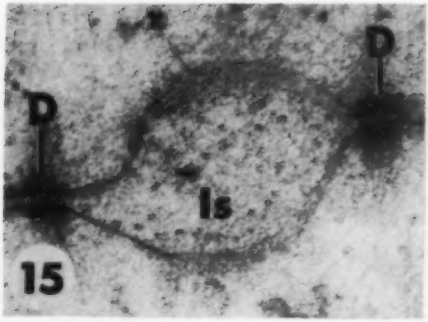
Fig. 15 (Teng). The cytoplasm is granular with little tonofibril formation. At the desmosome there is thickening of the cell membrane with accumulation of dense material, and some intercellular substance. The fibrils are indistinct in the intercellular area. (×57,000.)

Fig. 16 (Teng). In the cytoplasm there is more formation of tonofibrils and the desmosome is shown here to be made of fibrils crossing from one cell into the other. (×60,000.)

Fig. 17 (Teng). The tonofibrils in the cytoplasm are very clearly shown. The desmosome looks definitely more fibrillar with the tonofibrils crossing both cell membranes and continuous with other tonofibrils in the cells. (×33,000.)

Fig. 18 (Teng). Normal human corneal epithelium under light microscopy. PAS stain. (S) Secretory epithelial cells. (E) Ordinary epithelial cells. (BM) Basement membrane. (BoM) Bowman's membrane. (St) Stroma.

Fig. 19 (Teng). Normal human corneal epithelium under light microscopy. PAS stain. (A) A white cell is piercing through the basement and Bowman's membranes. The perforation causes a leakage of material from the basement membrane into Bowman's membrane, forming a new membrane along the surface of the break (Br).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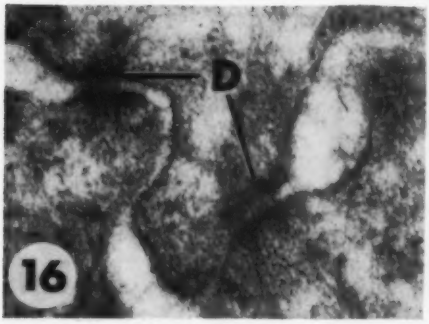
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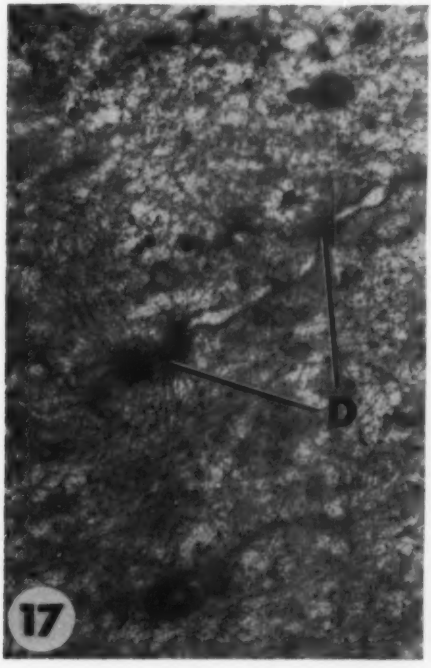
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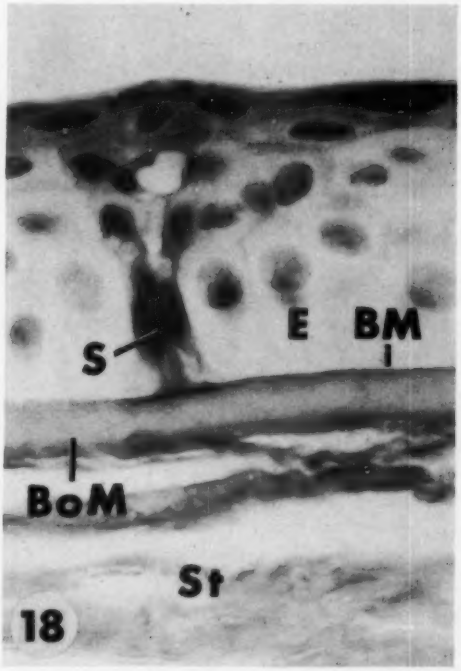
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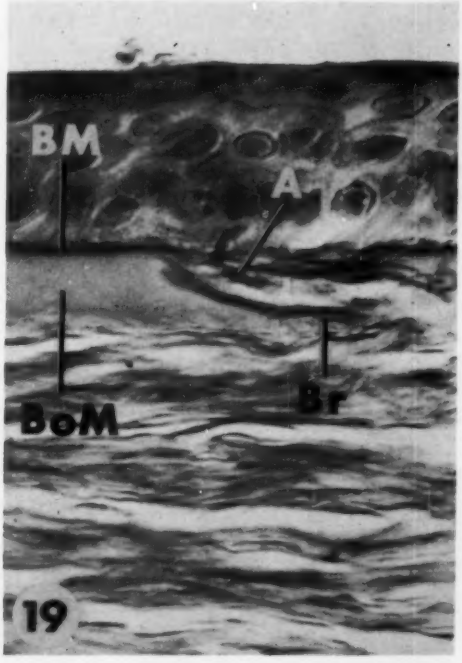
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able to demonstrate this, however, only in the wing cell layer where the tonofibrils are most abundant.

Three main factors may account for the difference between the two theories: (1) tissue variation, (2) the physiologic stage of the tissues, and (3) the merit of Watson's special stains which we used to excellent effect. The demonstration of tonofibrils especially may depend on the use of this stain, which some investigators may not yet have had a chance to use.

To illustrate the stages of tonofibril formation and change of appearance of desmosomes in human corneal epithelium, compare Figures 15, 16 and 17. In Figure 15, from a basal cell, the cytoplasm looks more granular in general and at the sides of the intercellular space or transient secretory capillary (IS) there are two desmosomes. These two look very much like those described by other electron microscope researchers.

Figures 16 and 17, from wing cells, show extensive tonofibril formation in the cytoplasm and it is evident that the same type of tonofibrils cross from one cell to another at the desmosomes, passing through the cell membranes. Thus the desmosome can be more fibrillar in cells where there is more tonofibril formation, or amorphous or granular in cells with less tonofibril formation, and probably they are capable of change through these various appearances. To resolve this question would require extensive study of many different tissues by various methods. It seems to us, however, that the two theories supplement each other, rather than conflict.

Secretory cells. A review of the literature shows that the secretory cell of the corneal epithelium has not yet been reported. In 1955 Wolff's book described two types of epithelial cells, but his description does not coincide with our observations. We believe that Cogan noticed this secretory cell, but he did not describe it in any great detail. In the legend of a picture he said that he thought this was a young epithelial cell. One reason why investigators seem to have overlooked this type of cell may be that normally they are very rare in the human cornea (figs. 18 and 19). In rabbit, cat and dog corneas there are comparatively more, and in the human cornea they increase in some pathologic conditions.

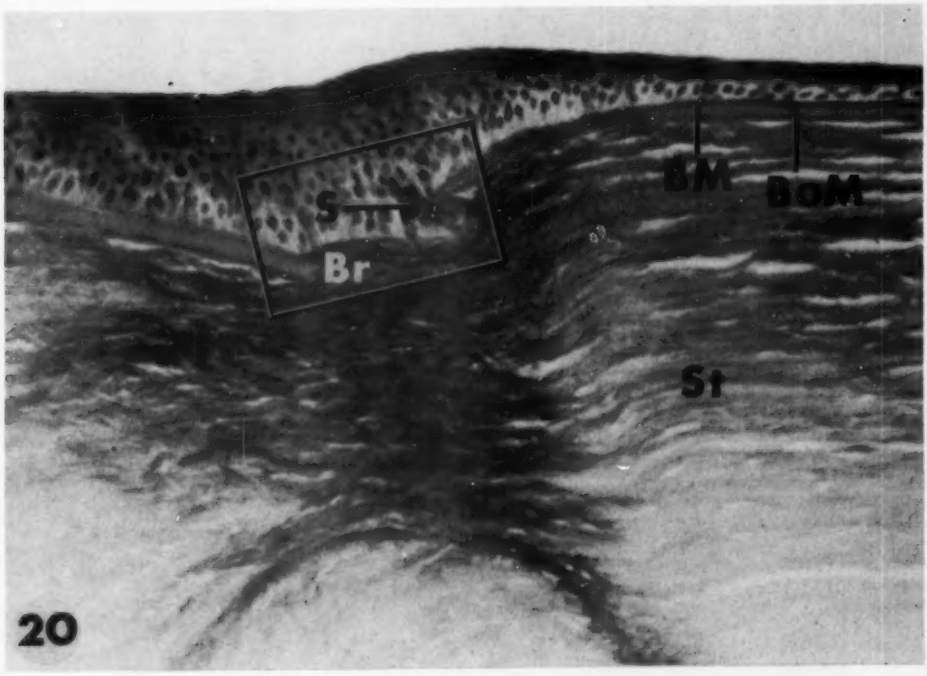
This cell first aroused our interest when we were studying the pathology of keratoconus, and we saw it again in our study of the anatomy of the functional filtering bleb after operation for glaucoma. In each of these conditions we noted an increase in the number of this type of cell.

Our light microscope study of keratoconus demonstrated that these secretory cells are closely related to the basement membrane. They have the same staining properties and often there are cellular processes extending from the secretory cell toward the basement membrane. Breaks in Bowman's membrane are a characteristic phenomenon in keratoconus and at this break there is often a leakage of PAS-positive substance from the basement membrane into the nearby stroma (figs. 20 and 21). Recently we demonstrated these findings under electron microscopy, as we will report in a separate paper.

All our observations indicate that the secretory cell is a unicellular, glandular structure, possibly comparable to the goblet cell, but secreting a distinctly nonmucoid sub-

Fig. 20 (Teng). Human cornea with keratoconus. PAS stain. The break of the basement and Bowman's membranes is characteristic of keratoconus. Note how PAS-positive material leaking from the basement membrane has collected in the stromal tissue at the break. (S) A few secretory cells. (BM) Basement membrane. (BoM) Bowman's membrane. (Br) Break in basement and Bowman's membranes. (St) Stroma.

Fig. 21 (Teng). Higher magnification of Figure 20.



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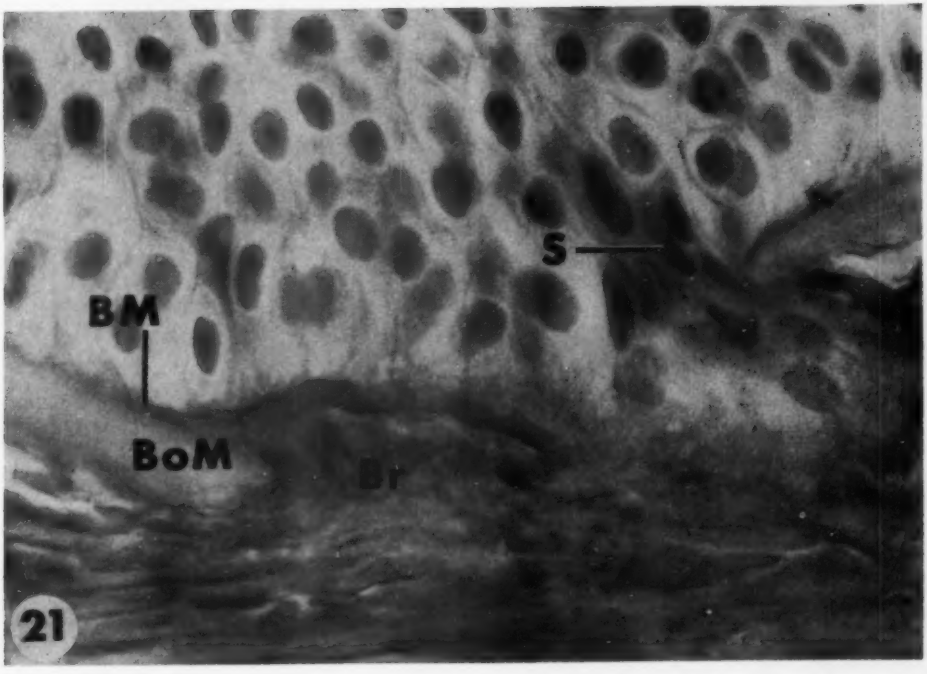

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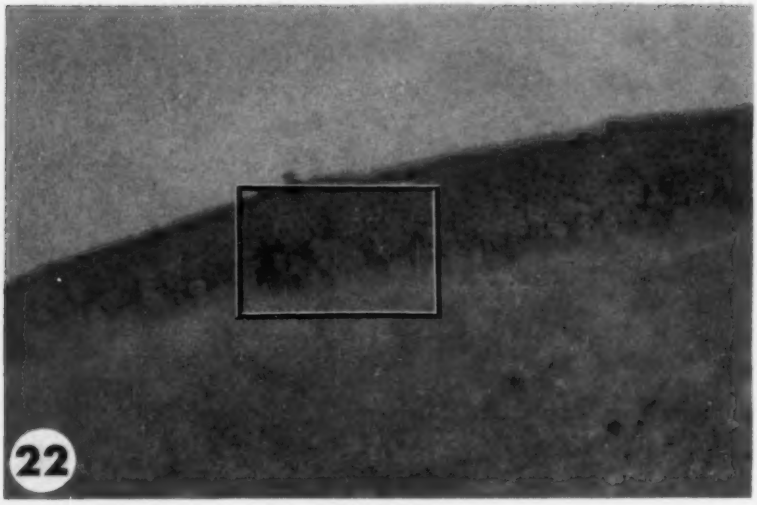


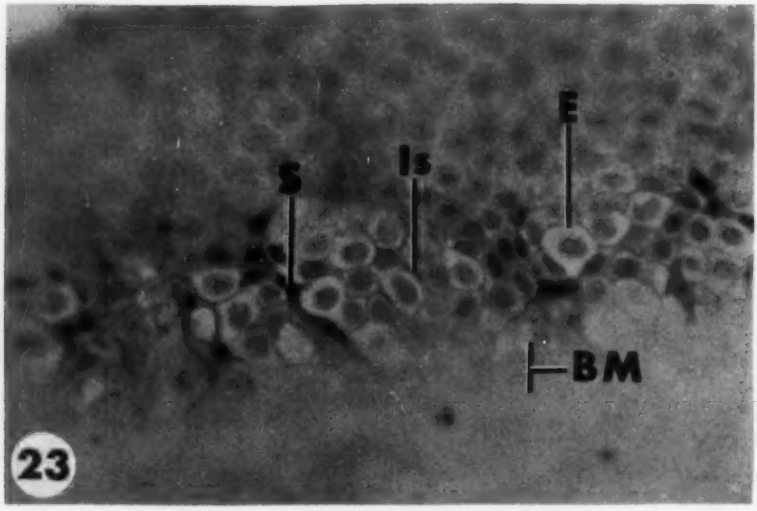
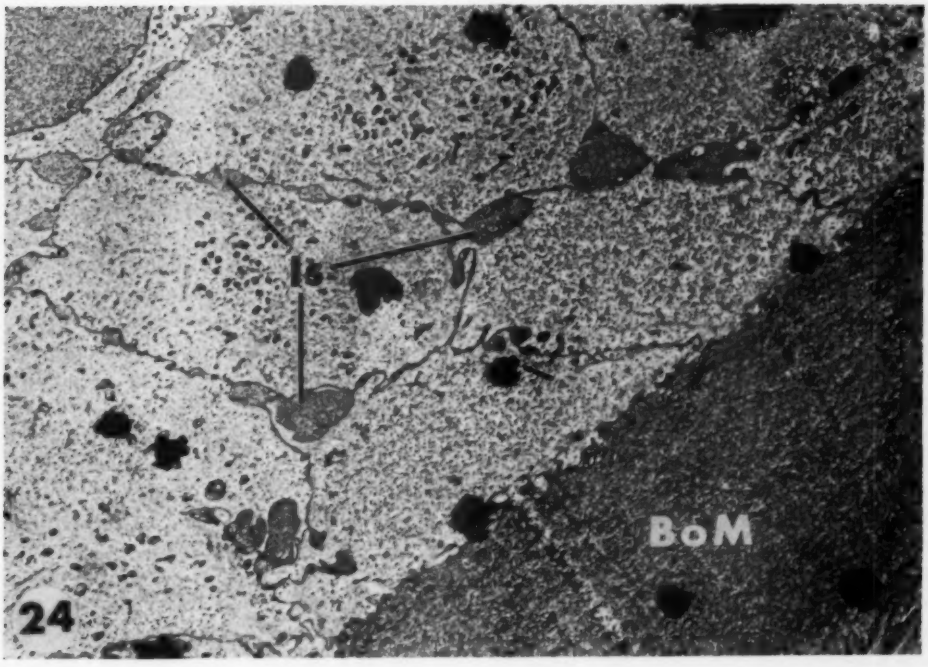


Fig. 22 (Teng). Oblique section of corneal epithelium from keratoconus case under light microscopy. PAS stain. Note increase of secretory epithelial cells which are PAS positive.

Fig. 23 (Teng). High power of area from Figure 22. (E) Epithelial cells. (S) Secretory epithelial cells. (BM) Basement membrane. (Is) Intercellular spaces which act as transient secretory capillaries. They are positive to PAS stain and are directly connected with the processes of the secretory cells.

Fig. 24 (Teng). Human keratoconus specimen showing general pattern, under electron microscopy, of the network of intercellular spaces (Is) acting as transient secretory capillaries. (BoM) Bowman's membrane.

Fig. 25 (Teng). General pattern of transient secretory capillaries (Is) in normal rabbit basal layer of corneal epithelium. Note similarity to human keratoconus specimen in Figure 24. (E) Epithelial cell.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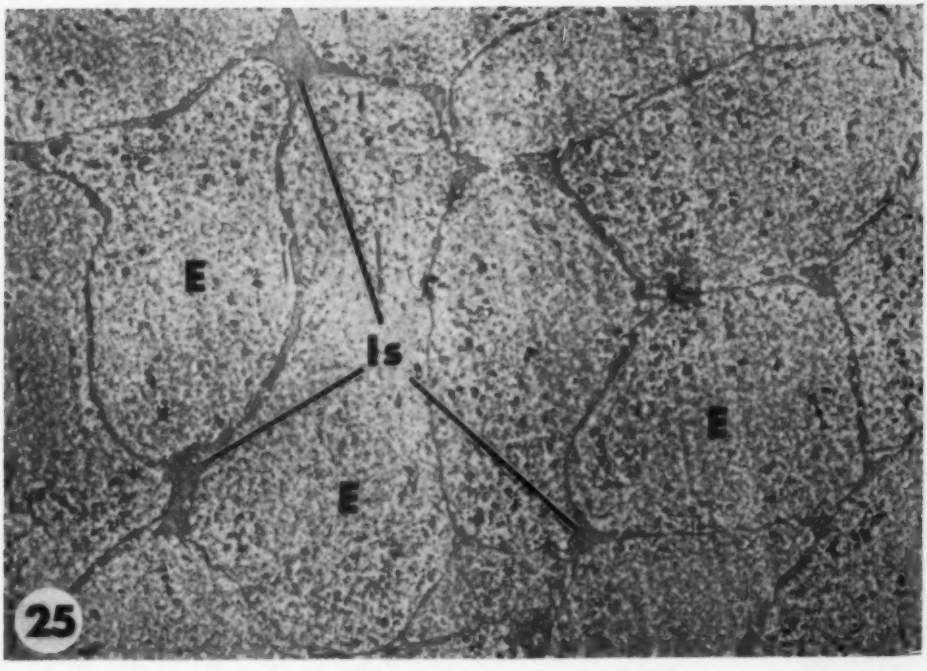
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stance. A comparison between this secretory cell and the goblet cell of the conjunctiva might prove interesting.

Our specimens show that the secretions of this cell supply the basement membrane of the cornea. The secretion is transmitted through the intercellular spaces, where it acts as a transitory secretory capillary. Occasionally large fragments, apparently from the cytoplasm, are found in the intercellular spaces, which may indicate that the cell wall is broken when the cell discharges this large particle. However, we have not as yet been able to demonstrate the mechanism of the discharge of secretion from the secretory cell.

The secretory cells are full of endoplasmic reticulum and have abundant osmophilic microsomes or Palade particles, both attached and free. These particles are very osmophilic and PAS positive. Cloude has realized for a long time that microsomes are composed of phospholipid-ribonucleoprotein complex, which agrees with our theory since we noted that the superficial layer of the corneal basement membrane is made of plasmalogen, a phospholipid. The degree of stain affinity of the secretory cell is variable; some stain darker than others. It may be that the light cells have discharged their secretions and the dark cells still carry it.

In our light microscope studies, trying to demonstrate the transient, secretory capillary, the thickest sections we made were still too thin to show PAS-positive staining with light microscope techniques. There are too few of these cells to find them by chance and get a good picture. In a human keratoconus specimen, however, we were able to show this point to a degree. In the oblique section shown in Figures 22 and 23 the corneal epithelium from a case of keratoconus shows an increase of secretory cells. Between the ordinary epithelial cells there are irregular secretory capillaries (IS). The secretory epithelial cells, secretory capillaries and basement membrane are all PAS positive. Under electron microscopy (figs. 24 and 25) the secretory capillaries in normal rabbit corneal epithelium resemble those in the basal layer of the human keratoconus specimen, and they contain similar secretory material (microsomes of 5.0 to 15 mμ). Figures 13 and 15 also show two kinds of particles in the secretory capillaries between the ordinary epithelial cells. These capillaries lead toward the basement membrane and help demonstate the direct relationship between the two structures. Since this similarity is found in normal rabbit corneas, it may be considered physiologic.

Although there are many more questions to be worked out, this evidence strongly suggests that the secretory epithelial cell is very closely associated with the basement membrane of the corneal epithelium.

Summary

1. A general picture of rabbit corneal epithelium as it appears under electron microscopy is presented.

2. Tonofibril formation and changes in different cell layers are discussed and the relationship to the appearance of the desmosomes is stressed.

3. A new apocrine type of secretory epithelial cell is reported together with our observation that it supplies the basement membrane with its secretory material.

4. Supporting evidence is presented for our previous speculation that the basement membrane of corneal epithelium is composed of a superficial layer of lipid, probably plasmalogen, and a posterior layer of reticular fiber meshwork which holds muco- or glycoprotein particles.

210 East 64th Street (21).

I wish to thank Dr. George Palade for his instruction and encouragement.

References

Cogan, D. G.: Applied anatomy and physiology of the cornea. Trs. Am. Acad. Ophth., **55**:329 (Mar.-Apr.) 1951.

Fawcett, D. W., and Selby, C. C.: Observations on the fine structure of the turtle atrium. J. Biophysic. & Biochem. Cytol., **4**:63, 1958.

Friedenwald, J. S., Buschke, W., and Crowell, J. E.: An exudate from injured cells and its relation to the healing of wounds of the corneal epithelium. Cell. & Comp. Physiol., **25**:45, 1945.

Hibbs, R. G., and Clark, W. H. J.: Electron microscope studies of the human epidermis: The cell boundaries and topography of the stratum Malpighi. J. Biophysic. & Biochem. Cytol., **6**:71, 1959.

Ishida, T.: A study of corneal tissue by electron microscope. Acta. Soc. Ophth. Japan, **62**:1324-1331, 2220-2227 (Sept., Nov.) 1958. Abstracted Am. J. Ophth., **47**:603, 1959.

Jakus, M. A.: Studies on the cornea: II. The fine structure of Descemet's membrane. J. Biophysic. & Biochem. Cytol., **2**:243 (suppl.) 1956.

———: Studies on the cornea: I. The fine structure of the rat cornea. Am. J. Ophth., **38**:40, 1954.

La Tessa, A. J., Teng, C. C., and Katzin, H. M.: The histochemistry of the basement membrane of the cornea. Am. J. Ophth., **38**:171, 1954.

Lehninger, A. L., and Schneider, M.: Mitochondrial swelling induced by glutathione. J. Biophysic. & Biochem. Cytol., **5**:109, 1959.

Lehninger, A. L., Rays, B. L., and Schneider, M.: The swelling of rat liver mitochondria by thyroxine and its reversal. J. Biophysic. & Biochem. Cytol., **5**:97, 1959.

Lever, J. D., and Chappell, J. B.: Mitochondria isolated from rat brown adipose tissue and liver. J. Biophysic. & Biochem. Cytol., **4**:287, 1958.

Odland, G. F.: The fine structure of the interrelationship of cells in human epidermis. J. Biophysic. & Biochem. Cytol., **4**:529, 1958.

Palade, G. E.: A study of fixation for electron microscopy. J. Exper. Med., **95**:285, 1952.

———: The fine structure of mitochondria. Anat. Rec., **114**:427, 1952.

———: Microsomes and Ribonucleoprotein Particles, Microsomal Particles and Protein Synthesis. Washington, The Washington Academy of Sciences, 1958, p. 36.

Porter, K. R.: Observations on the fine structure of animal epidermis. Proc. Internat. Conf. Electron Micro., London, 1954, pp. 539-547.

———: Observations on the submicroscopic structure of animal epidermis. Anat. Rec., **118**:433, 1954.

Ranvier, L. A.: Nouvelles recherches sur le mode d'union des cellules du corps muquieux de Malpighi. Compt. Rend. Acad. Sc., **89**:667, 1879.

Satir, P. G., and Peachey, L. D.: Thin sections: II. A simple method for reducing compression artifacts. J. Biophysic. & Biochem. Cytol., **4**:345, 1958.

Schwarz, W.: Electronen Mikroskopische untersuchungen ueber den Aufban der Sklera und der Cornea des Menschen. Ztschr. Zellforsch., **38**:26-40, 1953.

———: Electronen Mikroskopische untersuchungen ueber die Differenzierung de Cornea und Sklerafibrillen des Menschen. Ztschr. Zellforsch., **38**:78-86, 1953.

Sebruyns, M.: Ultrastructure de la cornee et du cristallin etudee au microscope electronique. Ann. ocul., **183**:483, 1950.

Selby, C. C.: The fine structure of human epidermis as revealed by the electron microscope. J. Soc. Cosmetic Chem., **7**:584, 1956.

———: An electron microscope study of the epidermis of mammalian skin in thin sections. J. Biophysic. & Biochem. Cytol., **1**:429, 1955.

Sheldon, H.: An electron microscope study of epithelium in the normal mature and immature mouse cornea. J. Biophysic. & Biochem. Cytol., **2**:253, 1956.

Teng, C. C., and Katzin, H. M.: The basement membrane of the corneal epithelium. Am. J. Ophth., **36**:895, 1953.

Van den Hooff, A.: Electron microscopy of cornea and sclera connective tissue. Proc. Kon. Med. Ak. v. Wet. Ser. C., **55**:628, 1952.

Watson, M. L.: Staining of tissue sections for electron microscopy with heavy metals. J. Biophysic. & Biochem. Cytol., **4**:475, 1958.

———: Staining of tissue sections for electron microscopy with heavy metals: II. Application of solutions containing lead and barium. J. Biophysic. & Biochem. Cytol., **4**:727, 1958.

———: Further observations on the nuclear envelope of the animal cell. J. Biophysic. & Biochem. Cytol., **6**:147, 1959.

Wolff, E.: The Anatomy of the Eye and Orbit, New York, McGraw-Hill, 1955, ed. 4, p. 34.

QUANTITATIVE DIAGNOSIS OF DEFECTIVE COLOR VISION*

A comparative evaluation of the Ishihara test, the Farnsworth dichotomous test and the Hardy-Rand-Rittler polychromatic plates

R. A. Crone, M.D.
Amsterdam, Holland

People with defective color vision are unsuitable for many occupations. The requirements for workmen in paint businesses, automobile sprayers, and textile dyers are strict. In all these occupations the workmen must be capable of making the finest distinctions in shades of color. For seamen and engine drivers on trains there must also be strict requirements. In the latter occupations it is, to a large extent, occupational responsibility that necessitates such high standards. In many other occupations slightly defective color vision is permissible but, if it is severe, it must lead to rejection.

A telephone mechanic, for instance, is unfit for his job unless he is able to distinguish the differences in the colors of the wires of a telephone cable. A salesman in a clothing shop must be able to pick out a tie that will go with a given shirt. A chemistry analyst will make mistakes if he is unable to determine the color of the indicator in titration. It goes without saying that a bus driver must at least be able to distinguish between red and green traffic lights. In all these occupations completely normal color sense is not essential but an applicant with a severe disturbance must be rejected.

For the practical differentiation between the degrees of color-vision defects, the customary classifications are not very useful. As is well known, congenital color vision defects are divided into:

1. *Anomalous trichomatism:* protanomaly, deuteranomaly, and tritanomaly.

2. *Dichromatism:* protanopia, deuteranopia, and tritanopia.

3. *Monochromatism:* total color blindness.

Total color blindness and trito-defects are so rare that they may be ignored in a treatise dealing with the practical side of color defects. The distinction between proto- and deutero-defects is also of little importance in practice so that only two groups remain: the red-green weak and the red-green blind. For two reasons even this last distinction is of no practical importance because (1) it is only to be ascertained by an anomaloscope, an expensive and inconvenient instrument for tests, and (2) in anomalous color vision all the transitions between normal and dichromatic vision appear.

If, therefore, it is the intention to separate red-green defectives into one group that is admissible for a given occupation and one group that must be rejected, it would be necessary to separate the anomalous themselves according to the degree of their color-vision defects. The dichromats would obviously make up the very end of the unfit.

A conclusion as to whether a particular person with a color-vision defect is acceptable for a given occupation requires the solution of two problems:

1. The discovery of a practical method for the quantitative diagnosis of the red-green anomaly.

2. Finding out, by investigating how it works out in practice, what are the minimum demands of a certain occupation in the way of color discrimination.

The search for a practicable method of quantitative diagnosis is the purpose of this paper. The following methods have been considered:

1. In principle a quantitative diagnosis can be made with the anomaloscope. No attention need then be paid to the numerical value of the red-green ratio (which indicates protanomaly or deuteranomaly) but only to the adjustment range, or scatter, of the various successive adjustments. As the adjust-

* From the University Eye Hospital.

ment becomes sharper the ability to distinguish colors becomes greater. Determination of the adjustment range necessitates an expensive instrument, considerable ability in handling it, and a fairly co-operative test subject. Furthermore, it is difficult to transpose the values obtained into a generally understood quantity. In practice, therefore, determination of the adjustment range is of little value for quantitative diagnosis.

2. The number of misread plates in a collection of pseudo-isochromatic plates would seem to be a simple way of gaining an impression of the seriousness of a color-vision defect. In this investigation the Ishihara test has been examined as to its usefulness for quantitative diagnosis.

3. The Farnsworth "dichotomous test" has been specially designed for quantitative diagnosis. This test consists of 16 Munsell paper chips of a diameter of one cm. and placed in ebony shells. The chips vary in color from blue via different shades of green, yellow, and red to violet. All the colors have virtually equal brightness and saturation for normal observers. With normal or slightly disturbed color vision the test subject can lay the chips in the proper sequence. With more marked disturbance, saturation differences between the various colors are seen, resulting in a faulty sequence. The sequence chosen by proto-defectives is different from that of deutero-defectives and different again from that of trito-defectives. The lines P, D and T indicate in which direction errors are made in the case of proto-, deutero- and trito-defects (fig. 1).

4. Another test making a quantitative diagnosis possible is the Hardy-Rand-Rittler polychromatic plates (1954). On these plates simple geometric figures are placed against a gray background. For the protanopes and protanomals there are red and blue-green figures, for the deutero-defectives purplish red and green.

The colors are thus those seen as colorless by dichromats. For the recognition of the rare disturbances in blue-green discrimination several other plates have also been added. The color of the figures veers from weak to strong saturation. The greater the number of figures missed, the stronger the color defectiveness. The degree of color defectiveness is divided into *light, medium,* and *strong* according to the number of misread plates. While these plates make it possible to distinguish between proto- and deutero-defects, they do not make it possible to distinguish between severe anomaly and dichromatism.

To be able to judge the usefulness of the various tests for quantitative diagnosis the degree of color defect of each test subject must be assessed by an exact measuring rule. Theoretically an excellent measuring rule would be the number of distinguishable hues in the spectrum between red and green. For this, however, the wavelength-discrimination curve would have to be determined, a very time-consuming business. Therefore, I have limited myself to taking one random test of spectral color differentiation, that of the threshold of wavelength discrimination in yellow (0.590 μ). By this determination a value $\Delta\lambda$ in mμ is obtained by which the color of a wavelength of 590 mμ + ½ $\Delta\lambda$ is precisely distinguishable from a color of the wavelength 590 mμ − ½ $\Delta\lambda$. The wavelength 590 mμ was selected in order to furnish data that could be compared to the adjustment range of the anomaloscope (Schmidt, 1952). In normal observers $\Delta\lambda$ (0.590 μ) amounts to about 1.0 mμ.

Course of investigation

Thirty protanomals and 45 deuteranomals between 12 and 18 years of age were examined. They were chosen for the investigation without any further selection during a mass investigation of color defects in the schools of Amsterdam. It may be taken for certain that the youngsters investigated made up a representative group of the anomalous or, to be more precise, that light cases did not escape the investigation. The Ishihara, Hardy-Rand-Rittler and Farnsworth tests

were given in a wooden cupboard containing two 150-Watt lamps, at a distance of 60 cm. from the tests and with an illumination angle of 60 degrees. In the wall of the cupboard there was a daylight filter (Friele and Selling, 1953) by means of which the test could be observed monocularly. The energy distribution of the light filtered in this way deviated only slightly from the energy distribution of the standard light source C. The answers with every plate and the sequence chosen for the Farnsworth colors were noted.

The threshold value of wavelength discrimination was determined according to my modified anomaloscope (Crone, 1955). Careful attention was paid so that color differences were judged with equal brightness of the test fields. The division into protanomals and deuteranomals was made in the usual way.

Results

Ishihara test

This test has great advantages and great disadvantages. The principal advantage is the great sensitivity which causes many mistakes to be made through even slight disturbances. Among the anomalous examined in this investigation not a single one made fewer than 10 mistakes (the plates for illiterates were not used). On the other hand the digits of the Ishihara test are often prac-

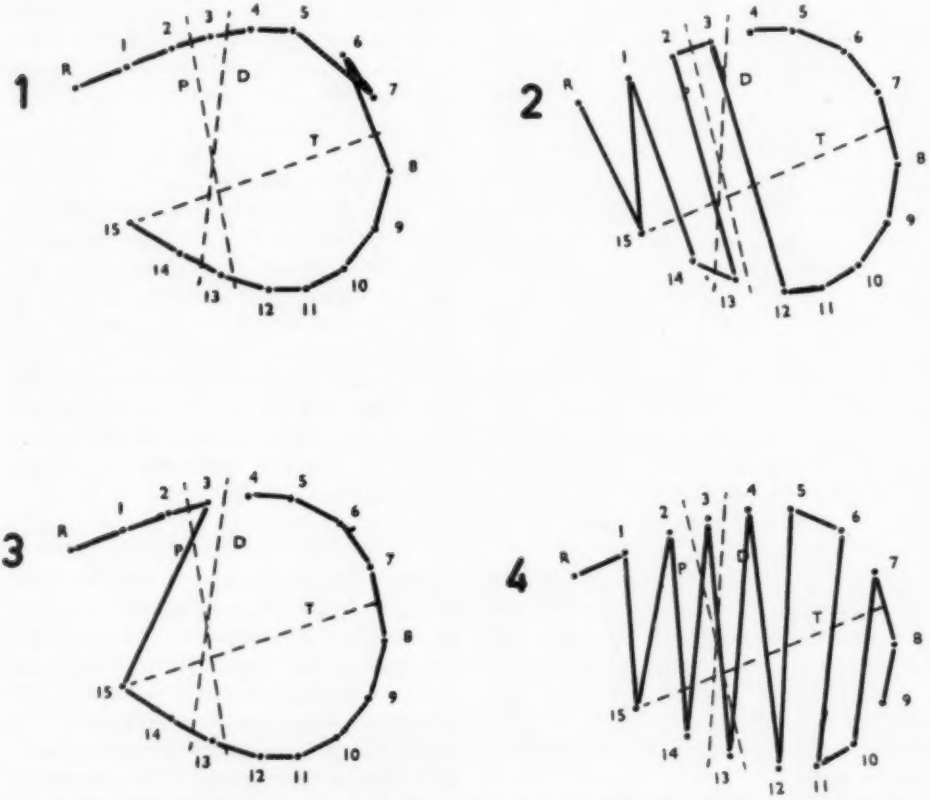

Fig. 1 (Crone). The Farnsworth dichotomous test. (1) Normal or slightly disturbed color vision. (2) Severe protanomaly (diverse crossings). (3) Moderately severe deuteranomaly (only one crossing). (4) Deuteranopia.

TABLE 1

CORRELATION BETWEEN NUMBER OF MISREAD ISHIHARA PLATES AND THEIR BLACK AND WHITE REPRODUCTIONS

Number of Misread Black and White Photos	Number of Test Subjects	Average Number of Mistakes in Ishihara Test
0	208	0.8
1	828	1.3
2	133	1.9

tically illegible for normals and mistakes are caused by general carelessness and inability to make sharp distinctions. The disadvantages are revealed in the following:

a. *Age* has an influence on the number of misread plates. In the school examination from which the color blind for this investigation were recruited, each pupil was given eight Ishihara plates to read. The average number of mistakes made by girls aged 12 and 13 years were compared with the average number made by girls aged 15 and 16 years. Girls aged 12 and 13 years made an average 0.84 mistakes; girls aged 15 and 16 years averaged 0.60 mistakes.

b. *Influence of discrimination ability in general.* During the same mass school investigation 1,169 boys and girls were given not only the eight Ishihara plates to examine but also three black and white photos of the plates. The pupils who read these three photos correctly made far fewer mistakes in the Ishihara test than those who made mistakes with the black and white photos.

Table 1 shows how inadequate ability to make sharp distinctions between uncolored objects may influence the results of the investigation with pseudo-isochromatic plates.

c. *The unequal value of the separate plates.* This is another disadvantage of the Ishihara test. Table 2 shows the number of correctly read plates among 100 red-green defectives and the number of misread plates among 100 normals. Through chance circumstances the normals included a number of heterozygotous women and also a number of children who had made mistakes in the school investigation but who upon subsequent examination proved to be normal. This makes the figures for normals more unfavorable.

A table similar to Table 2 was presented by Belcher, Greenshields and Wright (1958). My totals are much higher than theirs.

Use of another edition (the 11th) would seem to me to be the principal reason for this. Other possible reasons are: the use of different light, the monocular examination, and the youthfulness and relatively mediocre intelligence of the test subjects.

According to the screening inefficiency number, the most useful of the Ishihara plates are No. 8, 10, 11, 14, 15, 16, 22, 23, 24 and 25. If one is particularly anxious not to miss any normals it is advisable to choose the easy plates 8, 14, 15, 22, 23, and 24. If the principal aim is not to miss any abnormals then the difficult plates, 6, 11, 12, 13, 16, and 18 are advisable. The other plates are of dubious value.

TABLE 2

THE VALUE OF THE INDIVIDUAL ISHIHARA PLATES
(The score of 100 defectives and 100 normals)

Plate Number of Ishihara Test	Number of Defectives Reading Correctly	Number of Normals Misreading	Screening Inefficiency Number
1	100	0	100
2	55	0	55
3	58	0	58
4	1	31	32
5	6	31	37
6	1	25	26
7	1	45	46
8	6	6	12
9	0	90	90
10	10	14	24
11	2	18	20
12	2	53	55
13	5	24	29
14	12	2	14
15	13	1	14
16	6	16	22
17	2	45	47
18	5	23	28
19	14	27	41
20	24	31	55
21	68	3	71
22	13	2	15
23	21	0	21
24	20	0	20
25	17	1	18

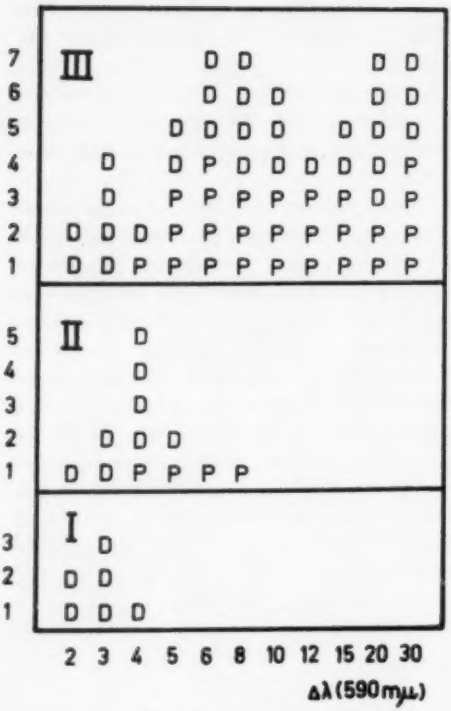

Fig. 2 (Crone). Ishihara test. Separation of the protanomals (P) and the deuteranomals (D) into three groups according to the number of mistakes. Horizontally: threshold of wavelength discrimination at 0.590 μ in mμ. Vertically: number of persons examined.

d. *Unsuitability for quantitative diagnosis.* The Ishihara test is inadequate for quantitative diagnosis. For this investigation the color weak subjects were divided into three groups: Group I: 10-15 mistakes in the Ishihara test; Group II: 16-20 mistakes; Group III: 21-25 mistakes.

Taking the threshold value of wavelength discrimination at 0.590 μ as a measuring rule it appears from Figure 2 that only a few slight cases of deuteranomaly fall into Group I. No serious cases of anomalous color vision appear in Group II either. In Group III severe and slight cases are all mixed up together.

Thus, anyone making less than 15 mistakes in the Ishihara test certainly has a slight disturbance. Anyone making a great many mistakes may have either a severe or a slight disturbance. This is the reason why the Ishihara test is unsuitable for a general quantitative diagnosis of defective color vision. The cause of its unsuitability cannot be given without further details. It seems to me that individual variations in the ability to distinguish shapes are not without influence.

Farnsworth dichotomous test

This test was developed for the purpose of differentiating between slight and severe cases of defective color vision. It is fundamentally impossible with this test to distinguish between normals and the slightly defective. When mistakes are made in the Farnsworth test, it is generally a simple matter to find out whether the color defectiveness belongs in the proto- or deuterogroup.

According to the results of the Farnsworth test I have again divided my material into three groups: Group I: Correct sequence of the colors or an occasional slip with adjoining colors; Group II: One crossing; Group III: More than one crossing.

According to the measuring rule used in this investigation the Farnsworth test does fulfill the requirements for quantitative diagnosis (fig. 3). There are, however, shortcomings. In the first group there are to be found a few protanomals with severe color defectiveness, while in Groups II and III various slight cases appear. That particularly severe protanomaly is able to slip through the mesh of this test probably results from the abnormal spectral sensitivity of protanomals. This leads to differences in brightness, which help the protanomals to place the colors in the proper sequence.

Hardy-Rand-Rittler polychromatic plates

For disturbances in red-green discrimination the H-R-R test provides the following plates: four *screening* plates for discrimina-

tion between normal and abnormal; five *mild* plates that are missed by the slightly color weak; three *medium* plates that are not read by the medium color defectives; two *strong* plates that are not read except in severe anomaly and dichromatism.

As far as red-green disturbances are concerned the H-R-R plates have a threefold purpose: recognition of abnormal color vision, division into proto- and deutero-defects, and quantitative diagnosis in three different degrees.

The usefulness of the H-R-R test for the identification of abnormal color vision is relative. The test was given to 49 protanomals, 78 deuteranomals, and 53 normals. Eleven normals missed one or more of the screening plates; 11 deuteranomals and one protanomal also missed one or more of the screening plates without making mistakes in the succeeding plates. Thus the H-R-R test makes no distinction between normals and abnormals with a slight disturbance.

The H-R-R test does better in distinguishing between proto- and deutero-defectives. In no case was a faulty diagnosis made. In two deuteranomals and one protanomal of the *mild* group, as well as in the abovementioned 12 mild color defectives who all only made mistakes in the screening plates, the diagnosis remained undertermined. In the majority of cases, therefore, the H-R-R test makes it possible to decide whether a given person has a proto- or deutero-defect. For practical purposes, however, this distinction is of almost no value.

The H-R-R test is excellent for quantitative differentiation. Again I have divided my material into three groups: Group I: H-R-R *mild*, or mistakes only in the screening plates. Group II: H-R-R *medium;* Group III: H-R-R *strong.*

According to the criteria used in this investigation the H-R-R plates make a reliable differentiation between slight and severe cases. The results appear in Figure 4. The boundary between *mild* and *strong* is in the region of $\Delta\lambda$ (490 mμ) = 10 mμ. The

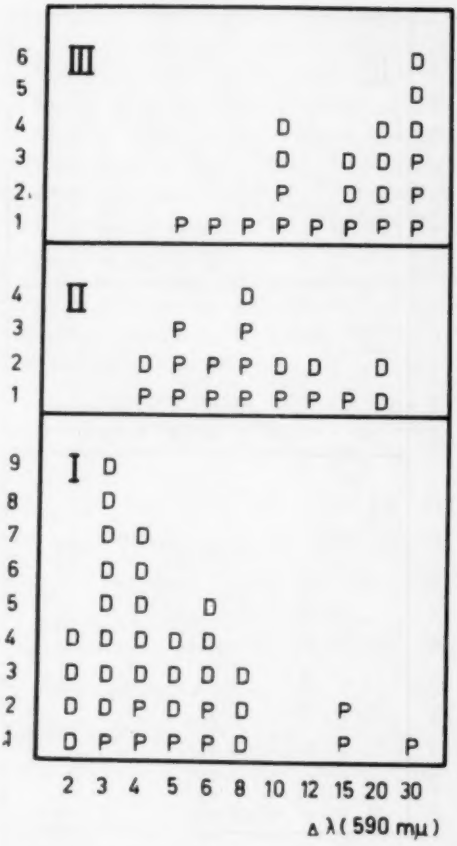

Fig. 3 (Crone). The Farnsworth dichotomous test. Separation of the protanomals (P) and the deuteranomals (D) into three groups with, respectively, no, one, or more crossings. Horizontally: threshold of wavelength discrimination at 0.590 μ (in mμ). Vertically: number of persons examined.

medium group overlaps the *mild* and *strong* groups.

The usefulness of the H-R-R plates is impressive but also somewhat unexpected. The colors lie exactly in the area of maximum color discrimination. In systematic investigations it is scarcely known that among the anomalous just at that point there is a minimum of purity discrimination, with such constant regularity and at such a constant point. The investigation by Chapanis (1944) is the only one that points in this direction.

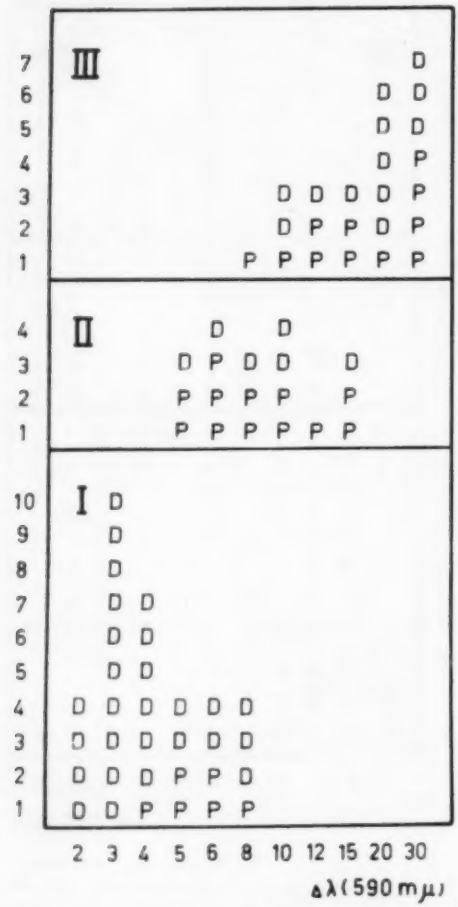

Fig. 4 (Crone). The Hardy-Rand-Rittler plates. Group I: H-R-R mild or negative; Group II: H-R-R medium; Group III: H-R-R strong. Horizontally: threshold of wavelength discrimination at 0.590 μ (in mμ). Vertically: number of persons examined.

Even in the case of dichromats it has long been uncertain whether protanopes could be distinguished from deuteranopes according to the location of their neutral zone in the spectrum. According to numerous investigations there was considerable overlapping between the neutral points of protanopes and deuteranopes. Not until the investigation of Walls and Heath (1956) was it demonstrated that the neutral points do not overlap. The efficiency of the H-R-R test would seem indirectly to confirm this investigation.

As for myself, I determined a series of neutral points in 19 protanopes and 24 deuteranopes (fig. 5). I also found little scatter and barely any overlapping, even though I used the spectral method which, according to Walls, is less accurate than the pigment-color method.

The H-R-R test depends on the presence of a sharp minimum in the saturation curve among the anomalous and on the difference in the location of this minimum among protanomals and deuteranomals. If the plates are to be usable a further requirement must be met: the brightness of the colors must not vary too strongly individually between the proto- or deutero-defects. That this is in fact not the case was once again confirmed by me (Crone, 1959) in a large number of anomalous subjects.

The fact that they are aimed only at the demonstration of insufficient saturation discrimination and not hue discrimination gives the H-R-R plates a unique place among the other pseudo-isochromatic plates. The benefit of this is a very efficient discrimination between proto- and deutero-defects. This would probably not have been possible by any other method. The principle of the H-R-R plate is also very good for quantitative diagnosis. For a differentiation between normal

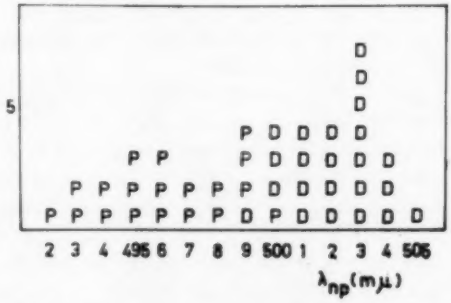

Fig. 5 (Crone). Neutral points in the spectrum of 19 protanopes and 24 deuteranopes. Comparison-white: 5,000°K. Horizontally: the wavelength of the neutral point. Vertically: number of persons examined.

and abnormal, however, the old principle of the Ishihara and Stilling plates would certainly have been preferable. Obviously in a slight case of anomaly it is the disturbance in green-yellow-orange discrimination that is first demonstrable. An increase in the number of screening plates, as proposed by Schmidt, would be useful but addition of some plates of the Ishihara type would probably be better.

Summary

The pseudo-isochromatic plates of Ishihara and Hardy-Rand-Rittler and the Farnsworth dichotomous test have been compared with each other. The usefulness of these tests has been judged particularly in respect to the quantitative differentiation of anomalous color vision. The threshold of wavelength discrimination at 0.590 μ was taken as the measuring rule. The Ishihara plates proved excellent for differentiation between normals and abnormals but were unsuitable for quantitative differentiation. The H-R-R plates, on the contrary, were unsuitable for differentiating between normals and abnormals but very good for quantitative differentiation. For the latter the Farnsworth dichotomous test was also usable, though to a lesser degree.

Wilhelmina Gasthuis.

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References

Belcher, S. J., Greenshields, K. W., and Wright, W. D.: Colour vision survey. Brit. J. Ophth., **42**:355, 1958.

Chapanis, A.: Spectral saturation and its relation to color-vision defects. J. Exper. Psychol., **34**:24, 1944.

Crone, R. A.: Clinical study of color vision. Brit. J. Ophth., **39**:170, 1955.

———: Spectral sensitivity in color defective subjects and heterozygous carriers. Am. J. Ophth., **48**:231, 1959.

Farnsworth, D.: The Farnsworth-Munsell 100 hue and dichotomous tests for color vision. J. Opt. Soc. Am., **33**:568, 1943.

Friele, L. F. C., and Selling, H. J.: Kunstmatig daglicht. Pamfl. 38, Vezelinstituut T.N.O., Delft, 1952.

Hardy, L. H., Rand, G., and Rittler, M. C.: The H-R-R polychromatic plates. Arch. Ophth., **51**:216, 1954.

Ishihara, S.: Tests for Colour Blindness. Tokyo, Kanehara Shuppan Co., 1954, ed. 11.

Schmidt, I.: Comparative evaluation of the Hardy-Rand-Rittler polychromatic plates for testing color vision. U.S.A.F. School of Aviation Medicine. Project No. 21-31-013, Randolf Field, Texas, 1952.

Walls, G. C., and Heath, G. G.: Neutral points in 138 protanopes and deuteranopes. J. Opt. Soc. Am., **46**:640, 1956.

AN ELECTROPHORETIC STUDY OF SOLUBLE LENS PROTEINS FROM DIFFERENT SPECIES*

Don C. Wood, Ph.D.
Portland, Oregon
and
Lurrine Burgess
Salt Lake City, Utah

Proteins of eye lens tissue have received much attention because of their important role in the pathogenesis of cataract. Investigators have attempted to isolate and purify the soluble proteins from different species; however, the total number of soluble lens

* From the Veterans Administration Hospital and Department of Pathology, University of Utah College of Medicine, Salt Lake City, Utah. This work was supported in part by United States Public Health Service Grants B-984 (C3) and B-2030. Presented in part at the annual meeting of the Federation of American Societies for Experimental Biology, Atlantic City, New Jersey, April, 1959.

TABLE 1

VARIATIONS REPORTED IN THE TOTAL NUMBER OF SOLUBLE PROTEINS ISOLATED FROM EYE LENS TISSUE

Reference	Specie	No. Proteins Reported	Technique Used
Morner[1]	Beef	2	Chemical isolation
Jess[2]	Beef	2	Chemical isolation
Burkey[3]	Beef	3	Chemical isolation
Hesselvik[4]	Beef	2	Free electrophoresis
Viollier[5]	Horse	2	Free electrophoresis
	Beef	2	Free electrophoresis
	Hog	2	Free electrophoresis
Smelser[6]	Mouse	3	Paper electrophoresis
Lewis[7]	Rabbit	2	Free electrophoresis
François[8,9]	Beef	3	Paper electrophoresis
	Hog	3	Paper electrophoresis
	Horse	3	Paper electrophoresis
	Rabbit	3	Paper electrophoresis
François[10]	Beef	8	Agar immuno-electrophoresis
François[11]	Human	10	Agar electrophoresis
Rao[12]	Beef	6	Immune (agar diffusion)
Halbert[13]	Rabbit	5	Immune (agar diffusion)
Halbert[14]	Rabbit	5	Immune (agar diffusion)
	Frog	6	Immune
	Human (Cataract)	7	Immune
	Fish	4	Immune
	Squid	5	Immune
Rupe[15]	Rabbit	8	Free electrophoresis
Wood[16]	Rabbit	5	Continuous flow electrophoresis
Witmer[17]	Human (Cataract)	3–5	Agar immuno-electrophoresis
	Mature	3	

proteins reported from various laboratories has resulted in some inconsistencies. Some of these differences are reviewed in Table 1.

It was the objective of this study to determine the electrophoretic behavior of soluble lens proteins from a variety of species and to report observations of fluorescing materials in the lens.

EXPERIMENTAL

MATERIALS AND METHODS

Continuous flow electrophoresis. The soluble lens proteins from freshly killed beef, hog, sheep, dog, cat, and chicken were extracted in saline and isolated by continuous flow electrophoresis according to Wood, et al.[16]

Agar electrophoresis. Lens proteins were separated by agar electrophoresis according to the following procedure: Difco Bacto Agar was purified in cutting a four-percent agar block into one cu. cm. squares and washing in 2N KOH for 24 hours. The agar was then washed 48 hours with cold tap water followed by a 24-hour rinse in distilled water. The distilled water was changed four times

during the rinsing period. Agar squares were placed in sterile weighed flasks, autoclaved, sealed and stored at 4°C. Prior to use, the agar was diluted with veronal buffer to yield a two-percent agar in a buffer of 0.02 ionic strength and pH 8.9. Two ml. of melted agar-buffer were transferred to an alcohol cleaned microscope slide and holes were cut in the agar with a No. 13-gauge hypodermic needle.

The slides were transferred to an electrophoresis cell containing the same buffer used in the agar preparation and a two to four-percent lens-protein sample was placed in the hole with a one ml. syringe and No. 27-gauge needle. Filter paper wicks connected the slides to the electrophoresis cells. The proteins were separated at 4°C. using 80 volts per slide for a period of one hour.

After electrophoresis the slides were stained for 10 minutes in Amido Schwartz 10B (0.5 gm. dye, 200 ml. acetone free methanol, 200 ml. distilled water and 30 ml. glacial acetic acid). The stained slides were decolorized in successive rinses of a solution containing 200 ml. methanol, 200 ml. distilled water, 40 ml. glacial acetic acid. The slides were then dried overnight at room temperature.

Starch column electrophoresis. A glass column, 24 by 70 cm., was filled with Baker's highest quality soluble potato starch which had previously been washed five times with veronal buffer similar to that used in the analysis. The larger starch granules were selected by decantation. All phases of the analysis involving the lens proteins were conducted at temperatures between 0-3°C. Lenses from freshly killed rabbits were removed, homogenized and centrifuged as in the continuous flow procedure. A three-ml. aliquot of the saline soluble proteins was applied to the column. The analysis was run in veronal buffer, pH 8.6 and ionic strength of 0.02 with 10 ma. current for a period of 60 hours. At the completion of the electrophoretic separation the proteins were eluted in the cold with veronal buffer at a rate of approximately 8.0 ml. per hour; 1.5 ml. fractions were collected in a Technicon drop-counting apparatus and subsequently analyzed for protein.

Results

Isolation by continuous flow electrophoresis. The soluble lens proteins from sheep, hog, cat, dog, chicken, and beef were extracted in saline and separated by means of

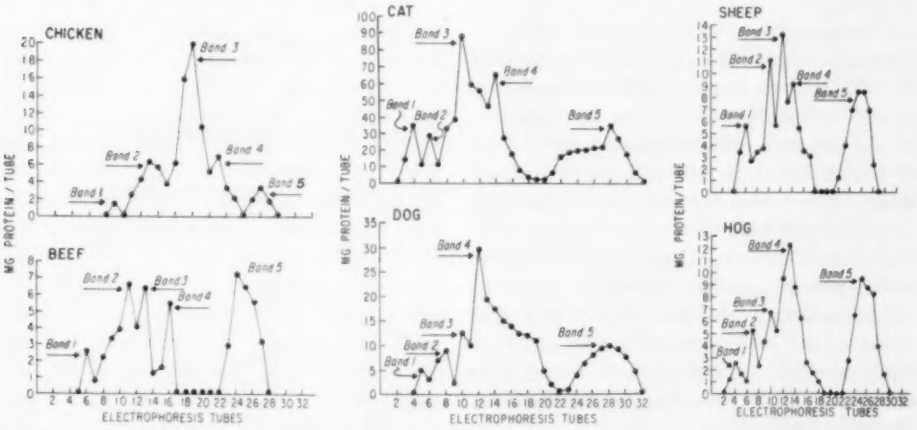

Fig. 1 (Wood and Burgess). Protein concentration curves from a continuous flow electrophoresis separation of soluble eye lens proteins from different species.

TABLE 2

EXAMINATION OF LENS PROTEIN SOLUTIONS FROM DIFFERENT SPECIES AS COMPARED WITH SODIUM BARBITAL AND BARBITURIC ACID

Test	Barbituric Acid (0.5% solution)	Sodium Barbital (0.5% solution)	Proteins (0.5% solution)
Biuret	No reaction	No reaction	Strong positive
TCA (20%)	No reaction	No reaction	Heavy precipitate
Boiling	No reaction	No reaction	Heavy coagulation
Putrifaction (room temp. 30°C., 1 mo.)	No reaction	No reaction	Strong putrid odor
	Barbituric Acid* (Crystals)	Sodium Barbital* (Crystals)	Protein* (Crystals)
Acetone	Soluble	Part soluble	Insoluble
Ether	Soluble	Part soluble	Insoluble
Benzene	Soluble	Part soluble	Insoluble
Ethanol (absolute)	Soluble	Part soluble	Insoluble
Ethyl Acetate	Soluble	Part soluble	Insoluble
Acetic acid (glacial)	Part soluble	Soluble	Insoluble

* 25 mg. of crystalline material was vigorously shaken with 5.0 ml. of solvent.

continuous flow electrophoresis as previously described. It was found that all six species gave protein separations on stained electrophoresis curtains which resembled those reported for rabbit.[16] Figure 1 shows the separation patterns as plotted from the total proteins collected in the 32 tubes. It can be seen that five distinct protein moieties separate by this technique; however, the pattern for chicken was remarkably different from the other species and from these data alone it is questionable whether five moieties are present.

Crystallization of the isolated proteins. Crystallization of the five proteins isolated from rabbit lens was first reported by Wood, et al.[16] Using this method, the fractions isolated from each species reported above were also crystallized. Needle patterns resembling those from rabbit fractions were observed. Crystals from each of the proteins were submitted to a variety of tests to differentiate them from the buffer reagents used in the crystallization procedure. All crystals were dissolved in 0.85-percent saline dialyzed overnight at 4°C. against distilled water, then examined. Results of this examination are shown in Table 2.

Nitroprusside test. Because the continuous flow electrophoresis patterns of these species resembled that previously reported for rabbit,[16] it appeared likely that the proteins were similar. It was concluded for rabbits, that band 5 was alpha crystallin and beta crystallin might consist of bands 1, 2, 3, and 4.

Reis[18] first showed fresh lens to give a strong positive nitroprusside reaction, and Jess[19] reported this reaction to be restricted to the beta crystallin. Each of the proteins was examined with this reagent. Following electrophoresis the proteins were dialyzed overnight against distilled water at 4°C. to remove buffer, free amino acids, glutathione, and other such components which might yield a positive reaction. Without exception, bands 1, 2, 3, and 4, in all species studied (rabbit, sheep, hog, cat, dog, chicken and beef), gave a strong positive reaction with the alkaline nitroprusside reagent. Band 5, on the other hand, gave only a slight to negative reaction. Denaturation of the proteins prior to examination intensified the reaction. The excellent work of Dische and Helena,[20] Kinoshita and Merola,[21, 22] and Thomann[23] has demonstrated the presence of considerable quantities of cysteine in the soluble proteins of the lens. The presence of this amino acid undoubtedly accounts for the positive nitroprusside reaction observed here and

suggests a relationship of these proteins to beta crystallin.

Agar electrophoresis. Because François, et al.,[10] claimed to have separated eight protein constituents from beef lens by means of agar electrophoresis, a similar technique was used to separate the soluble proteins from the lenses of the different species. Fresh lenses were extracted in 0.9-percent saline and separated electrophoretically as previously described. From Figure 2 it can be seen that, under the conditions of these experiments, four to five bands appear in all species except chicken which contained three.

A variety of different extractants was used to determine whether or not alterations

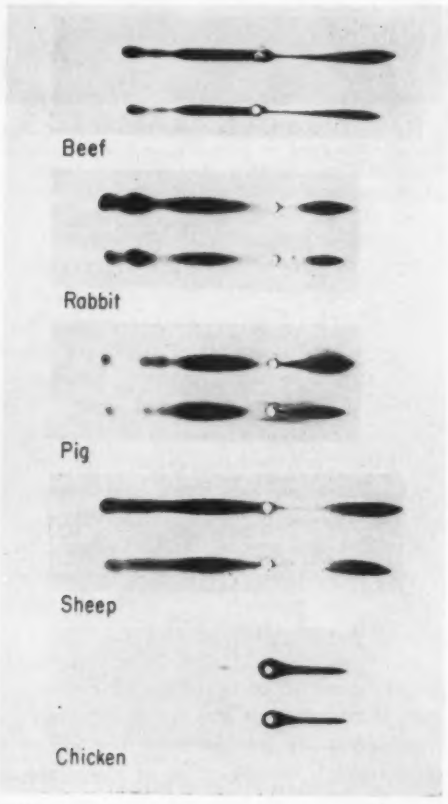

Fig. 2 (Wood and Burgess). Agar electrophoresis patterns of the soluble proteins in rabbit, beef, pig, sheep and chicken eye lens.

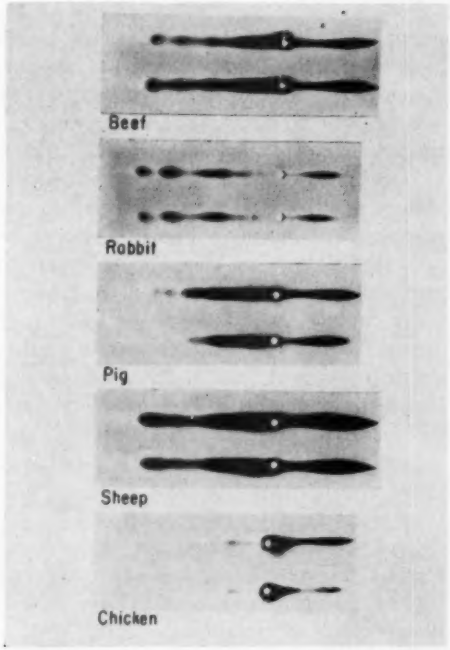

Fig. 3 (Wood and Burgess). Agar electrophoresis patterns of a single freeze-thaw treatment of the soluble proteins in rabbit, beef, pig, sheep, and chicken eye lens.

in the proteins might occur due to oxidation or some other factor peculiar to the saline extraction. The lenses were extracted in triple distilled water, 0.1 M mercaptoethanol (to measure possible S-S linkage splitting), one-percent sodium ascorbate and 0.02 ionic strength veronal buffer at pH 8.9. The resulting agar electrophoresis patterns of the extracted proteins from these solvents were essentially identical with the saline patterns.

It can be seen from Figure 3 that agar electrophoresis patterns of saline solutions which had been permitted to freeze and thaw resulted in a more distinct separation of the proteins and in some cases a different distribution of the proteins was observed. Although the differences between frozen and unfrozen extracts are small, they are consistent and indicate changes and alteration in the protein resulting from freezing.

Starch column electrophoresis. In an attempt to find a simple and more gentle method for isolating soluble lens proteins, starch column electrophoresis was used. The soluble proteins from rabbit lenses were extracted and separated on a starch column electrophoresis apparatus and eluted as previously described. The results from this experiment are shown in Figure 4. It can be seen that six protein components appear to separate during the analysis. Two proteins move rapidly toward the anode while four slower-moving components separate further up the column. A total of 224.2 mg. of protein were applied in a three-ml. aliquot and 214.3 mg. of protein were recovered. This represents a 95.6-percent recovery and suggests a complete representation of all proteins applied.

This separation, though not identical, resembles the continuous flow electrophoresis separations previously reported[16] for the soluble proteins of rabbit lens.

Fluorescing compounds of the lens. Regnauld[24, 25] first reported a blue fluorescing compound in the lens. Setschenow[26] found a bluish-white material and v. Sepibus[27] demonstrated a compound with yellowish-green fluorescence. Fischer[28–30] was the first to isolate and identify any of the substances.

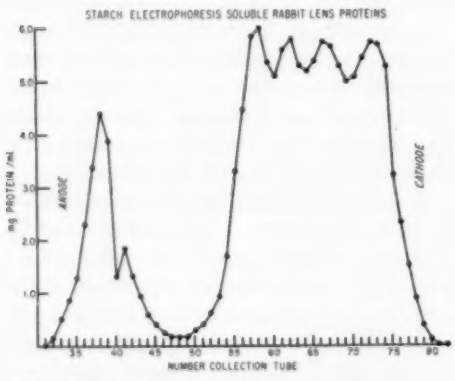

Fig. 4 (Wood and Burgess). Protein concentration in the eluted fractions from a starch column electrophoresis separation of soluble rabbit lens proteins.

Fig. 5. (Wood and Burgess). Ultraviolet fluorescence observed on a continuous flow electrophoresis lower curtain after electrophoretic separation of the soluble proteins from rabbit eye lens.

He separated a green fluorescing material which was identified as a riboflavin complex and a blue fluorescing compound which he believed to be dimethyl alloxazine. Fischer[31] believed that by photolysis riboflavin would break down to form dimethyl alloxazine. Karrer, et al.,[32] and Kuhn and Rudy[33] could not find riboflavin in lens; however, Philpot and Pirie[34] reported it present in the lens of beef. Many workers have confirmed the presence of blue, green and yellow fluorescing materials; however, little is known about these compounds or their biologic function. Klang[35] has reviewed the important literature on this subject.

It appeared likely that these compounds might be separated by means of continuous flow electrophoresis and for this reason the fluorescence of lens extracts was observed by flooding a lower curtain, of a typical lens protein separation, with ultraviolet light prior to staining the separated proteins. Three different fluorescing pigments were found to

separate by this technique. The three components were: (1) a yellow substance which moves almost directly off the curtain toward the anode, (2) a very thin red fluorescing band which moved rapidly to the anode appearing approximately one inch above the path of the alpha crystallin, and a third substance, (3) a blue-green fluorescing material which moved with all of the protein constituents. The latter material appeared to be in highest concentration.

Figure 5 represents such a fluorescing pattern of a dried lower curtain which was subilluminated with ultraviolet light from a Woods' lamp. When the rabbit lens solution was dialyzed prior to electrophoresis the fluorescing materials were almost completely removed. The compounds appear to have a small molecular size and, at least, the blue-green material is loosely absorbed to protein.

The absorption spectrum of the blue-green fluorescing material was measured with a Beckman model DU spectrophotometer using a hydrogen lamp light source. Readings were made at room temperature (28°C.) in a one-cm. silica cell. The fluorescing material was taken from a continuous flow collection tube which showed no measurable quantity of protein. The sample was diluted with distilled water to within the reading range. Veronal buffer diluted in a similar manner was used as a blank. Both the blank and unknown were at pH 7.4. A single even curve with an absorption peak at 238 to 240 mμ wave length was obtained. There was no evidence of another chemical group which would absorb light in either the visible or ultraviolet regions.

The presence of these three compounds has been observed in lenses from rabbits, dogs, cats, mice, beef, hogs, chickens, and sheep.

Discussion

It has been shown from the preceding data, that soluble lens proteins of beef, hog, sheep, dog, and cat can be separated into at least five components which migrate at different rates in the continuous flow electrophoresis apparatus. The electrophoresis patterns resemble those previously reported for rabbit lens.[16] Though solutions from chicken lens also yield five proteins the distribution and resolution of the proteins suggest that these moieties are remarkably different from the other species studied.

It is of particular interest that four of the five proteins isolated from each species gave positive nitroprusside reactions and that the fast anode moving component was essentially negative. This, with other data previously described, suggests that the old beta crystallin, reportedly nitroprusside positive, is a mixture of proteins.

The similarity between continuous flow and agar electrophoresis patterns was surprising. It was at first believed that the milder and shorter procedure employed in agar electrophoresis might result in better resolution and separation than that found with continuous flow electrophoresis. The disadvantages of this method are obvious. Because the method employs such a small initial sample, proteins which are in low concentration may never appear as a distinct band. Also, because the beta crystallins have similar migratory patterns and are difficult to separate by electrophoresis, it is easy to mask a similar but not identical protein. François,[10] using an agar electrophoresis technique, found eight different proteins in beef lens. His procedure involved a much higher current and migration over a longer agar field than that which was used in these experiments. This might explain the difference here reported.

Agar electrophoresis of fresh lens solutions which had been frozen and thawed showed a remarkably better degree of resolution of the proteins and in some species a difference in the distribution pattern. This suggests that either (1) proteins are being denatured resulting in large peptide structures with different migratory patterns or (2) some binding groups or charges which hold bundles of proteins together are being altered resulting in a better resolution of the

different protein constituents of the lens. Because a single freeze-thaw consistently demonstrated this change, electrophoretic and immunologic data must be cautiously evaluated until more is known about the effects of freezing, high voltages, adjuvants and other physical and chemical factors on the lens proteins.

The use of starch column electrophoresis as used in these experiments offers some advantages in the isolation of lens proteins. The simplicity and mild treatment of the proteins in a relatively inert system, at low current and refrigeration temperatures, may account for the even separation of the proteins and the percent recovery obtained. Six protein components were isolated from rabbit lens by this method. The small protein band which moved toward the anode with the alpha crystallin (fig. 4) might be the contaminant reported by Wood, et al.[16] in the ultracentrifuge analysis of rabbit lens proteins isolated with the continuous flow electrophoresis apparatus. The migration pattern as shown by starch column electrophoresis would identify the protein with the region of separation in which the contaminant was found.

Because the electrophoretic methods reported here suggest the presence of five or six soluble proteins in lens tissue, we do not wish to imply that other soluble proteins may not be present. The large amount of immunologic data reported from many different laboratories strongly suggests the presence of many soluble lens proteins. On the other hand, serious consideration must be given to the possibility that only two or three different proteins are normally present in the intact lens. In fact, it could be argued that these data lend support to such a premise.

Though separate protein bands are seen in the continuous flow electrophoresis separations (fig. 1) four of these (the slower moving components) are always closely grouped together. This fact is even more evident in the starch electrophoresis shown in Figure 4. The difference in protein content of tube No. 59 (366 mg. percent) as compared with tube No. 61 (320 mg. percent) is only 44 mg. percent. In spite of the consistent reproduction of this electrophoretic pattern, the reality of these differences should be questioned. A review of the previous paper by Wood, et al.,[16] on rabbit lens proteins suggests almost identical values for this slow-moving group of proteins, with regards to isoelectric point, Svedberg units and crystallization characteristics.

It is possible that the four slower-moving components have a common parent which, in the intact lens, could be a single complex protein containing disulfide linkages. During the process of extraction and under the conditions of chemical or electrophoretic separation, the disulfide bonds are broken yielding several smaller protein units. These polypeptides could differ only in a few amino acids residues which might account for the differences seen during electrophoresis and could also explain the multiple bands observed by the immunologic procedures.

It is also conceivable that this protein cleavage is influenced in vivo by the aging process and is an important factor in the development of senile cataract. This is supported indirectly by some observations in our laboratories where the best electrophoretic separations have been obtained from the lenses of older animals. Also, there is a rapid loss of beta crystallin in senile cataract. Such a "denaturation" process could account for the increase in insoluble proteins reported by Dische, et al.[36] during the development of experimental cataract.

More exacting answers to th nterrelationship of lens proteins must obviously await detailed physical and chemical data on the isolated components.

The significance and role of fluorescing compounds in the soluble fraction of the lens remains completely unknown. Three different fluorescing compounds were separated by continuous flow electrophoresis and it was shown that all were dialyzable. The blue-green fluorescing substance which appears in

highest concentration was loosely bound to the lens proteins and had an absorption maximum at 238 to 240 mμ. This substance could be similar to that reported by Fischer.[80] Inasmuch as the metabolic pathways for the lens have not been clearly described and some question remains as to the exact mechanism of energy formation, it is of interest to note that some of the vitamins such as vitamin A, thiamine, riboflavin, niacin, pyridoxine, biotin, vitamin, vitamin D, vitamin E, and so forth, have absorption maxima in the ultraviolet region and are fluorescent. Perhaps further information on the nature and function of the fluorescing compounds of the lens might offer greater information as to the metabolic pathways of the lens.

Summary

1. Five protein constituents were isolated and crystallized from the soluble lens proteins of beef, hog, sheep, cat, and dog. Differences between electrophoretic patterns of proteins from chicken lens and other species were shown.

2. Similar patterns were observed for the various species using a microagar electrophoresis procedure.

3. A starch column electrophoresis technique was used to separate six protein components from rabbit lens. Its value and relationship to the other electrophoretic procedures were discussed.

4. Three fluorescing components of the lens were separated by continuous flow electrophoresis and the implication of their presence in the lens was discussed.

700 Northeast 47th Avenue (13).
Veterans Administration Hospital (13).

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References

1. Mörner, C. T.: Ztschr. Physiol. Chem., **18**:61, 1894.
2. Jess, A.: Arch. f. Ophth., **109**:463, 1922.
3. Burkey, E. L., and Woods, A. C.: Arch. Ophth., **57**:464, 1928.
4. Hesselvik, L.: Skand Arch. Physiol., **82**:151, 1939.
5. Viollier, G., Labhart, H., and Sullmann, H.: Helv. Physiol. & Pharmacol. Acta, **5**:10, 1947.
6. Smelser, G. K., and von Sallmann, L.: Am. J. Ophth., **32**:1703, 1949.
7. Lewis, L. A.: Electrophoresis in Physiology American Lecture Series. Springfield, Ill., Thomas, 1950.
8. François, J., Wieme, R., Rabaey, M., and Neetens, A.: Soc. Belge ophtal., **104**:322, 1953.
9. ———: Experientia, **10**:79, 1954.
10. François, J., Rabaey, M., Wieme, R. J., and Kaminski, M.: Am. J. Ophth., **42**:577, 1956.
11. François, J., and Rabaey, M.: Am. J. Ophth., **44**:347, 1957.
12. Rao, S. S., Kulkarni, M. E., Cooper, S. N., and Radhakrishman, M. R.: Brit. J. Ophth., **39**:163, 1955.
13. Halbert, S. P., Locatcher-Khorzao, D., Swick, L., Witmer, R., Seegal, B., and Fitzgerald, A.: J. Exper. Med., **105**:439, 1957.
14. Halbert, S. P., and Fitzgerald, P. L.: Am. J. Ophth., **46**:187, 1958.
15. Rupe, C. D., Monsul, R. W., and Koenig, V. L.: Radiation Research, **8**:265, 1958.
16. Wood, D. C., Massi, L., and Solomon, E. L.: J. Biol. Chem., **234**:329, 1959.
17. Witmer, R. H.: Arch. Ophth., **61**:738, 1959.
18. Reis, W.: Arch. f. Ophth., **60**:558, 1912.
19. Jess, A.: Arch. Ophth., **42**:45, 1913.
20. Dische, Z., and Helena, Z.: Am. J. Ophth., **34**:104, 1951.
21. Kinoshita, J. H., and Merola, L. O.: Am. J. Ophth., **46**:36, 1958.
22. Kinoshita, J. H., and Merola, L. O.: Arch. Biochem. & Biophy., **81**:395, 1959.
23. Thomann, H.: Arch. f. Ophth., **160**:219, 1958.
24. Regnauld, J.: L'Institut, 1858, p. 410.
25. ———: J. Pharm. & Chim., **37**:104, 1860.
26. Setschenow, J.: Arch. f. Ophth., **5**:205, 1859.
27. v. Sepibus, J.: Ztschr. f. Augenh., **29**:407, 1913.
28. Fischer, F. P.: Brit. M. J., **1**:776, 1934.

29. ———: Arch. f. Augenh., **108**:527, 1934.
30. ———: Arch. f. Augenh., **109**:468, 1936.
31. ———: Nederl. tijdschr. v. geneesk., **81**:2985, 1937.
32. Karrer, P., Salomon, H., Schopp, K., Schlittler, E., and Fritzsche, H.: Helv. Chim. Acta, **17**:1010, 1934.
33. Kuhn, R., and Rudy, H.: Ber. d. deutsch. Chem. Gesellsch., **67**:1936, 1934.
34. Philpot, F. J., and Pirie, A.: Biochem. J., **37**:250, 1943.
35. Klang, G.: Acta Ophth. Supplement., **31**:7, 1948.
36. Dische, Z. and Borenfreund, E.: AMA Arch. Ophth., **55**:633, 1956.

ELECTROPHORETIC STUDY OF CORNEAL PROTEINS*

Comparative analysis of corneal protein fractions in different animal species

Saeko Watanabe, B.Sc., and Jun Tsutsui, M.D.
Okayama-shi, Japan

In our previous experiments on corneal heterografts, it appeared that little donor-recipient reaction occurred and the grafts healed in a transparent condition in the transplantation of fish cornea into rabbit cornea.[1] On the other hand, grafts of the human, dog, and ox into rabbit corneas almost always healed in opaque condition after extensive donor-recipient reaction.

In the recent experiment of Basu and Ormsby,[2] interlamellar grafts with epithelium resulted in almost double the number of clear transplants with homografts than with heterografts. When the epithelium was removed from the donor tissues prior to grafting, donor-recipient reaction was prevented. We also noticed this phenomenon[3] and also that lyophilized ox cornea with and without epithelium produced less donor-recipient reaction than fresh grafts.

The most important key for the success of corneal heterograft is believed a reduction of the antigenicity of soluble corneal proteins which may be a cause of donor-recipient reaction. The problem of donor-recipient reaction is important in heterografts as well as in homografts. As a step toward solution of these problems, comparative analysis of corneal protein by means of paper electrophoresis was done and the relationships between donor-recipient reaction and proteinograms of corneas were observed.

Material and Method

Materials

Corneas employed in this experiment were taken from human, rabbit, ox, goat, pig, chick, Rana esculenta, Exocoetidae, Scomber scombrus japonicus, Lateolabrax japonicus, Thunnus orientalis and Seriola quinqeradiata. Electrophoretic runs were made three to 12 times on each kind of cornea. All the materials were frozen just after the donor had died and the analysis was started within 24 hours' storage.

Extraction of soluble proteins

After weighing the material, the tissue was dissected by scissors until it became paste. An equal amount of distilled water was added to the tissue paste and it was frozen and thawed 10 times with alcohol-dry ice mixture. The specimen was kept for 12 hours at 4°C. to allow the extraction of soluble proteins. In some corneas, such as

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human, ox, rabbit, goat and pig, the tissue absorbed so much of the added water that another addition of an equal amount of distilled water was necessary. After grinding the tissue paste, the specimen was centrifuged at 10,000 rpm for 10 minutes under refrigeration. The corneas of chick, frog and fish absorbed so little water that the second addition of water was not necessary.

Electrophoresis

The supernatant fluid (0.06 cc.) containing the proteins was placed on the starting point of the filter paper (Whatman No. 1). Electrophoresis was performed with barbituric buffer at pH 8.6 for five to six hours with 400 v., 0.3 to 0.8 ma./cm. of current. The mobilities of the separable components of pH 8.6 soluble proteins were compared with human serum proteins run simultaneously.

Results

Human cornea (fig. 1)

Separation of the water-soluble proteins of human cornea showed five distinct fractions and three less clear fractions. Five distinct fractions travelled with the same mobility as serum albumin (Al.) and each globulin (Gl.) fraction. Three less clear fractions lay between γ Gl. fraction and the starting point. It was peculiar that concentration of albumin was lower than that of serum. Fractions which appeared at the position of Al. (29.8 percent), β Gl. (17.2 percent) and γ Gl. (29.8 percent) showed relatively higher percentage than the others.

Rabbit cornea (fig. 1)

Proteinograms showed eight fractions of which five were clearly distinguishable and the others were indistinct. Fraction I (27.4 percent) lay in the same region as serum Al., II (2.9 percent) as α_1 Gl., III (2.4 percent) as α_2 Gl. and IV (9.4 percent) as β Gl., V (8.1 percent) lay between β Gl. and γ Gl., VI (29.3 percent) as α Gl., VII (3.7 percent) and VIII (10.6 percent) lay between γ Gl. and the starting point.

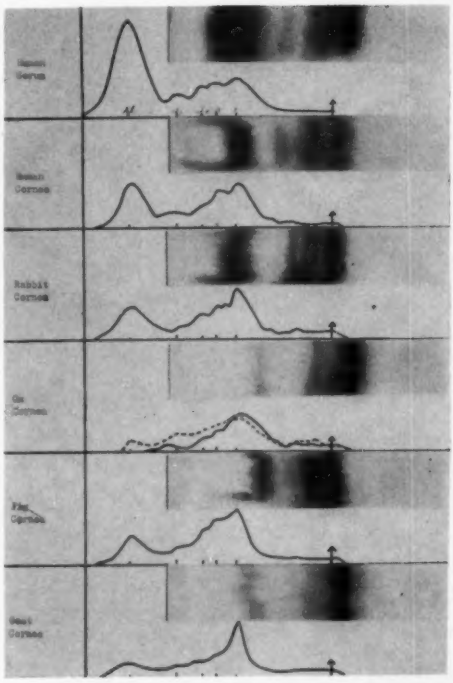

Fig. 1 (Watanabe and Tsutsui). Electrophoretic pattern of water-soluble corneal proteins.

Ox cornea (figs. 1 and 2)

Four distinct fractions and two indistinct fractions were recognized. Fraction I (9.0 percent) sometimes showed the same mobility as serum Al. but mostly lay between Al. and α_1 Gl. Fractions II (18.0 percent), III (6.5 percent) and IV (48.3 percent) correspond to α_2, β, γ Gl. respectively. Fractions V (4.8 percent) and VI (13.0 percent) appeared between γ Gl. and the starting point. In the specimens of the epithelium in which protein concentration was much higher than the stroma, two distinct and three indistinct fractions were recognized (fig. 2). Fractions I (38.0 percent) and II (65.0 percent) revealed with α_2 Gl. and γ Gl. respectively and fraction III (7.0 percent) lay between γ Gl. and the starting point. In the stroma, three

TABLE 1

DISTRIBUTION OF PROTEIN COMPONENTS

	Albumin Position Percent	Globulin Position Percent								Starting Point ↓
		α_1		α_2		β		γ		
Human serum	57.69	6.54		8.55		9.66		17.54		
Human cornea	29.85	8.01		8.22		17.22		29.85	2.63	2.22 1.97
Rabbit cornea	27.42	2.92		9.40		9.44	8.15	29.34	3.74	10.61
Ox cornea	9.01			18.02		6.54		48.32	4.86	13.04
Ox cornea	17.92	17.65						42.68	9.95	11.78
Ox epithelium				38.08				65.08		7.06
Ox stroma	10.54			16.40				73.04		
Pig cornea	19.89	5.58		20.35		8.23		37.05		8.87
Goat cornea	13.24	6.06	4.58			7.59		44.65		6.02
Chick cornea	17.11	7.47		18.28		11.78	17.83	35.50	9.32	
Frog cornea			4.21	2.82		7.53		64.34	2.24	15.14
Exocoetidae	1.98			12.96			8.92	62.72		13.39
Scomber scombrus japonicus		12.12				3.71		62.48		11.64
Lateolabrax japonicus		9.70	6.15				20.66	20.01		15.33
Thunnus orientalis				15.90			8.14	61.70		14.24
Seriola quinqueradiata		21.98		10.24	18.97		14.15	30.12	4.51	

distinct components, I (10.5 percent) was between Al. and α_1 Gl., II (16.4 percent) and III (73.0 percent) were the same mobility as α_2 Gl. and γ Gl. (fig. 2).

PIG CORNEA (fig. 1)

Five distinct fractions and one indistinct fraction were recognized. Five distinct fractions, I (19.9 percent), II (5.6 percent), III (20.3 percent), IV (8.2 percent) and V (37.0 percent) were the same position as the serum Al. and each Gl. Fraction VI (8.9 percent) was between γ Gl. and the starting point.

GOAT CORNEA (fig. 1)

Four distinct and three indefinite fractions appeared. Four distinct fractions, I (13.2 percent), II (4.6 percent), IV (7.6 percent) and VI (44.6 percent) corresponded to the mobility of the serum Al. and α_1, β, γ Gl. respectively. Indistinct fraction III (4.6 percent) lay between α_1 Gl. and α_2 Gl. and V (17.8 percent) was between β and γ Gl.

CHICK CORNEA (fig. 2)

Five distinct and one indistinct fractions were separated. Five distinct fractions, I (17.1 percent), II (7.5 percent), III (18.3 percent), IV (11.8 percent) and V (35.5 percent) showed the same mobility as the human serum components. The indistinct fraction (9.3 percent) lay between γ Gl. and the starting point.

FROG (RANA ESCULENTA) CORNEA (fig. 2)

Three distinct fractions and three indistinct fractions were recognized. Fraction I (4.2 percent) and II (2.8 percent) lay between α_1 Gl. and α_2 Gl. Fraction III (7.5 percent) and IV (64.3 percent) appeared at the position of β Gl. and γ Gl. Fraction V (2.2 percent) and VI (15.1 percent) were between γ Gl. and the starting point.

EXOCOETIDAE (FLYING-FISH) CORNEA (fig. 3)

A distinct and four indistinct fractions were demonstrated. Fraction I (1.9 percent)

lay between Al. and α_1 Gl. position. Fraction II (12.9 percent) was between α_1 Gl. and α_2 Gl., III (8.9 percent) between β Gl. and γ Gl., IV (62.7 percent) was the same mobility as γ Gl., and V (13.4 percent) lay between γ Gl. and the starting point.

SCOMBER SCOMBRUS JAPONICUS (MACKEREL) CORNEA (fig. 3)

Four distinct and one indistinct fractions were separated. Fraction I (12.1 percent) was between Al. and α_1 Gl., II (2.1 percent), III (3.7 percent) and IV (62.5 percent) appeared the position of α_2, β and γ Gl. respectively. Fraction V (11.6 percent) lay between γ Gl. and the starting point.

LATEOLABRAX JAPONICUS (PERCH) CORNEA (fig. 3)

Five distinct and one indistinct fractions were demonstrated. Fraction I (9.7 percent)

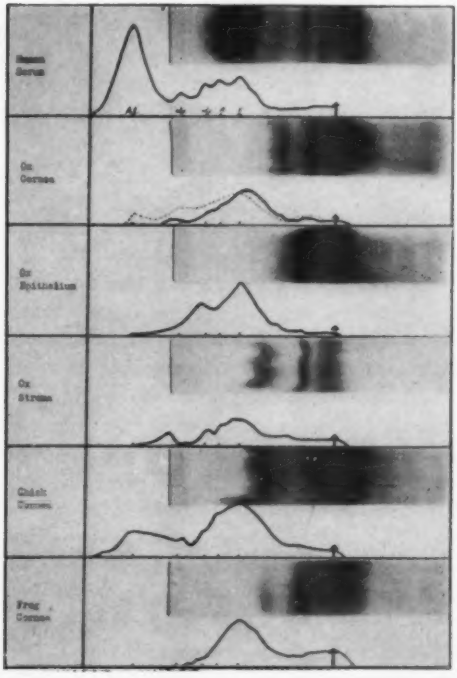

Fig. 2 (Watanabe and Tsutsui). Electrophoretic pattern of water-soluble proteins.

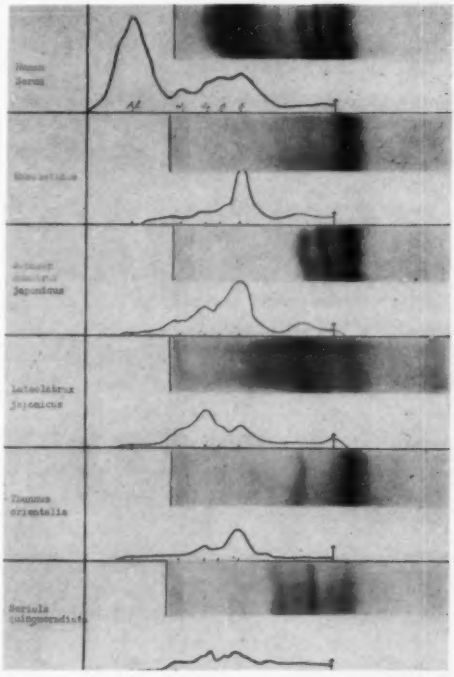

Fig. 3 (Watanabe and Tsutsui). Electrophoretic pattern of water-soluble proteins.

was between Al. and α_1 Gl., II (6.2 percent), III (28.1 percent) and V (20.0 percent) corresponded to the position of α_1 Gl., α_2 Gl. and γ Gl. respectively. Fraction IV (20.7 percent) was between β Gl. and γ Gl. and VI (15.3 percent) was between γ Gl. and the starting point.

THUNNUS ORIENTALIS (TUNNY) CORNEA (fig. 3)

Three distinct and one indistinct fractions appeared. Fraction I (15.9 percent) and III (61.7 percent), corresponded to α_2 Gl. and γ Gl. Fraction II (8.1 percent) lay between β Gl. and γ Gl., IV (14.2 percent) between γ Gl. and the starting point.

SERIOLA QUINQUERADIATA (YELLOWTAIL) CORNEA (fig. 3)

Five distinct and one indistinct fractions were demonstrated. Fraction I (21.9 per-

cent), II (10.2 percent) and V (30.1 percent) corresponded to the position of α_1 Gl., α_2 and γ Gl. respectively. Fraction III (18.9 percent) lay between α_2 Gl. and β Gl. and IV (14.2 percent) between β Gl. and γ Gl. Fraction IV (4.5 percent) was between γ Gl. and the starting point.

Discussion

In our previous experimental keratoplasty,[1] little donor-recipient reaction followed the interlamellar corneal heterografts of fish into rabbit cornea. On the contrary, human, ox and dog corneas produced extensive donor-recipient reaction in rabbit cornea. The difference of donor-recipient reaction was thought to be due to the difference of antigenic property of corneal proteins.

In order to clarify this concept electrophoretic analysis of soluble corneal proteins from different kinds of animals was carried out. Analyses of corneal proteins by means of electrophoresis have reported by several workers, Smith and Woodin,[4] François and Rabaey,[5] W. Madalinska and M. Madalinska,[6] Gerkowicz,[7] Kobayashi[8] and Takaku.[9] No one, however, has reported on the comparative difference of protein components in different kinds of animals under the same experimental conditions.

According to the results of our experiments, one of the corneal soluble proteins of which electrophoretic mobility was the same as albumin of the human serum appeared in most of mammalian and chick corneas. In ox cornea, the fraction that appeared in the albumin position frequently deviated to the side of the α_1 Gl. position, so that the component seemed to have a similar electrophoretic property as albumin. On the other hand, as this kind of protein component never appeared in any fish cornea the antigenic property may exist in this component. The chick cornea which produced a little donor-recepient reaction in the rabbit cornea[10] also showed a relatively higher concentration in a fraction at the position of the serum albumin. This evidence suggests that this component seems to be composed of a collection of different kinds of antigenic proteins. This concept could not be proved satisfactorily in this series of research, so further experiments for proving this evidence are planned.

Kuwahara[11] reported the successful lamellar corneal heterograft of chick into a human eye. Although the proteinograms of chick and rabbit corneas were similar to that of human, one of these, rabbit cornea, could not bring a successful result in transplantation to human cornea. Therefore, the similarity of the proteinogram does not mean the suitability of donor material in corneal heterograft.

Ox cornea with epithelium usually produced an intensive donor-recipient reaction in the rabbit cornea but only little donor-recipient reaction in stroma. The epithelial layer contains most of the soluble proteins so that the distribution of antigen is much higher in this layer than in the stroma. The difference of proteinogram between epithelium and stroma was demonstrated but the evidence could not give any explanation for the donor-recipient reaction.

Summary

Little donor-recipient reaction occurred in the transplantation of fish cornea into rabbit cornea. On the contrary, donor materials from human, dog and ox into rabbit cornea were almost always healed in an opaque condition. To clarify this evidence, electrophoretic analysis was done on corneas of human, rabbit, ox, pig, goat, chick, frog and five kinds of fish. Human cornea showed eight fractions of which five were distinct and corresponded to the component of the human serum. Eight fractions appeared in rabbit cornea of which five were distinct and corresponded to the component of the human serum. Ox cornea demonstrated four distinct and two indistinct fractions. The concentration of soluble protein in the epithelial layer was much higher than that of

stroma and there was a difference in the proteinogram. Pig cornea contained five distinct and one indistinct fractions. Chick cornea had five distinct and one indistinct fractions, and their arrangement was similar to the proteinogram of human cornea. Characteristic findings in the proteinogram of frog and fish corneas were the lack of albumin position component. These data suggest that the component which appeared at the position of albumin is considered to have a powerful antigenic character in corneal transplantation.

1 Midorimachi, Chikko.

References

1. Tsutsui, J., and Watanabe, S.: Corneal heterograft of fish cornea into rabbit eyes. Am. J. Ophth., **48**:363, 1959.
2. Basu, P. K., and Ormsby, H. L.: Corneal heterografts in rabbits. Am. J. Ophth., **44**:477, 1957.
3. Tsutsui, J., and Watanabe, S.: Unpublished data.
4. Smith, C. H., and Woodin, A. M.: A note on the antigenic properties of corneal extracts. Brit. J. Exper. Path., **34**:647, 1953.
5. François, J., and Rabaey, M.: Les proteins de l'epithelium corneen. Bull. Soc. belge. ophtal., **108**: 641, 1955.
6. Madalinska, W., and Madalinska, M.: Electrophoretic investigation of corneal albumin. XXV Zjazdu Okulist. Pols., **2**:409, 1957.
7. Gerkowicz, K.: Electrophoretic research into fraction of albumin of the corneal endothelium. Referat. XXV Zjazdu Okulist. Pols., **2**:413, 1957.
8. Kobayashi, S.: Corneal proteins: I. Electrophoretic pattern of normal rabbit. Acta. Soc. ophth. jap., **60**:584, 1957.
9. Takaku, I.: Ultracentrifugal and electrophoretic studies of the transparent media of the eye. Acta Soc. ophth. jap., **61**:1821, 1957.
10. Kamata, W.: An experimental study of heterokeratoplasty. Acta Soc. ophth. jap., **61**:1098, 1957.
11. Kuwahara, Y.: Successful transplantation of chicken cornea into human cornea. J. Clin. Ophth., **10**:963, 1956.

Ophthalmic Miniature

Cure by suction: When we find practitioners subjecting patients with established cataracts to a course of treatment both local and general, we are greatly inclined—to use no harsher term—to question their experience, and when we find men proposing new methods of operating, such as cutting out a cataract through the sclerotic, and advising depression or breaking up indiscriminately, in preference to extraction through the cornea, we are very much inclined to doubt their capability of performing that dexterous operation.

W. R. Wilde,
"Report on the progress of ophthalmological surgery,"
Quarterly Journal of Medical Science, 1848.

NOTES, CASES, INSTRUMENTS

AIR INJECTION TO PREVENT SYNECHIAS IN KERATOPLASTY*

DANIEL W. DOCTOR, M.D.
Westport, Connecticut

Anterior synechia is a frequent and serious complication of keratoplasty. Although its presence does not necessarily cancel the chances for a clear graft, the adhesion often leads to vascularization, secondary membrane formation, glaucoma, and clouding of the graft. Even with improved instrumentation and increased surgical experience the incidence of anterior synechias is still high. Castroviejo[1] considered it one of the most frequent complications of keratoplasty. In Fine's[2] series of 100 cases the incidence ran about 15 percent and Leahey's[3] and Paton's[4] reported cases showed a similar percentage. In a series of consecutive corneal grafts done at Manhattan Eye, Ear and Throat Hospital the incidence ran as high as 27 percent.

In view of the conditions which exist after the last suture is placed, it is not surprising that the synechias form. The anterior chamber is flat, there is surgically induced iritis, and the wound edges are not always tightly sealed. Often air or normal saline is injected to separate the cornea from the iris lens diaphragm, at least long enough to allow the wound margin to seal and the anterior chamber to reform.

One method of injecting air into the anterior chamber is to place a bulb syringe or air injection needle at the wound margin and try to force air into the chamber without disturbing the coaptation of the edges (fig. 1-A). This method has the advantage of safety but the disadvantage of infrequent success. More often the surgeon actually inserts the needle through the edges of the wound and injects the air, preferably without entering the anterior chamber (fig. 1-B). All too often, however, the needle does enter the chamber before the air is injected, possibly causing lens trauma and almost certainly opening a spot in the wound margin which did not previously exist. This may lead to a leak, preventing the retention of the air.

Seeing the disadvantages of these methods of air injection and noting the frequency of anterior synechias, it was decided to use another technique.

TECHNIQUE

The donor button is obtained in the usual manner (fig. 2). Two preplaced sutures are placed in the donor button 180 degrees apart, using 7-0 silk on a Grieshaber needle (fig. 3).

Prior to trephining the recipient eye, a penetrating incision is made into the anterior chamber near the limbus using a sharp-pointed Ziegler knife stained with methylene blue. This provides a track through which

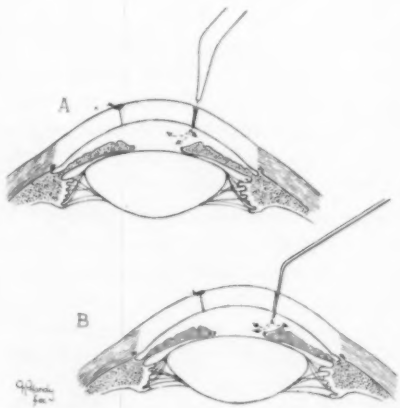

Fig. 1 (Doctor). (A) This method of air injection does not disturb the coaptation of the wound edges but it is sometimes unsuccessful. (B) This method of air injection is more easily accomplished but it disturbs the coaptation of the wound edges and may sometimes traumatize the lens.

* Aided by The Eye-Bank for Sight Restoration, Inc. This paper was presented in part before the VI Pan-American Congress of Ophthalmology, Caracas, Venezuela, February, 1960.

air may subsequently be injected, using a 30-gauge needle (fig. 4). The recipient eye is then trephined until aqueous presents (fig. 5) and the button is cut out with curved corneal scissors (fig. 6).

The donor button is brought into position, as shown in Figure 7, and sutured. For a six-mm. graft I use a total of eight direct sutures. The 30-gauge needle is then used to inject air through the preplaced track. The air should be retained if the button is properly aligned and sutured (fig. 8).

Leakage sites can easily be detected and should be repaired by extra sutures (fig. 9). Air is injected again and must be retained before the patient leaves the operating room. If the iris is incarcerated in the wound margin, it too can be detected by the pocketing of air around the affected suture (fig. 10) and must be repaired by removing the suture and allowing the iris to fall back, then resuturing. Air is again injected.

Comment

This technique of using a preplaced track for air injection, previously described[6] in other types of intraocular surgery, has, I feel, excellent application in penetrating keratoplasty. It has several distinct advantages. First, the oblique angle of entry is less likely to injure the lens; second, the wound margin is not disturbed; third, if leaks are present, they can be detected as the air escapes and sutures can be added until the injected air is retained; fourth, accidental incarceration of the iris can be detected and remedied; and

Fig. 2 (Doctor). Donor button is trephined in the usual manner.

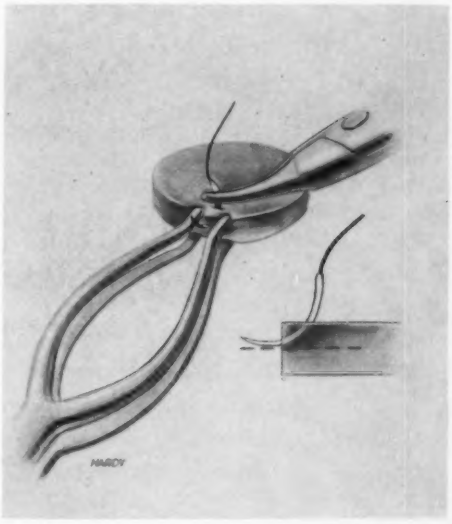

Fig. 3 (Doctor). Placing sutures in the donor button.

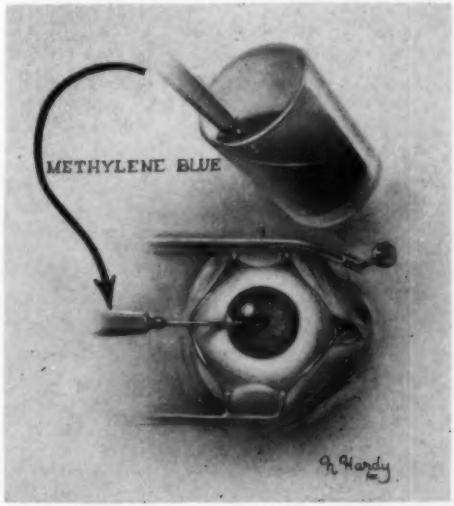

Fig. 4 (Doctor). Track incision is made into the anterior chamber, using a sharp-pointed Ziegler knife stained with methylene blue.

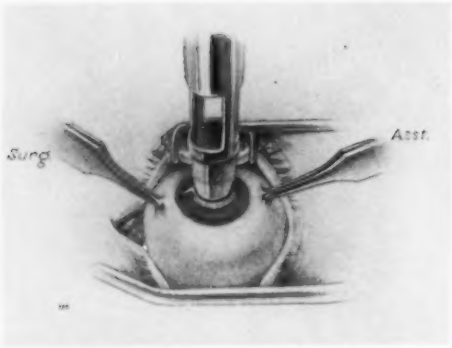

Fig. 5 (Doctor). Trephining the recipient eye.

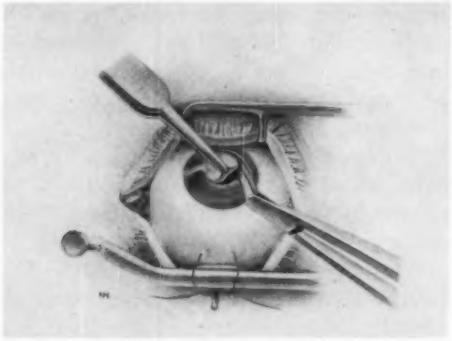

Fig. 6 (Doctor). Excision of the button from the recipient eye.

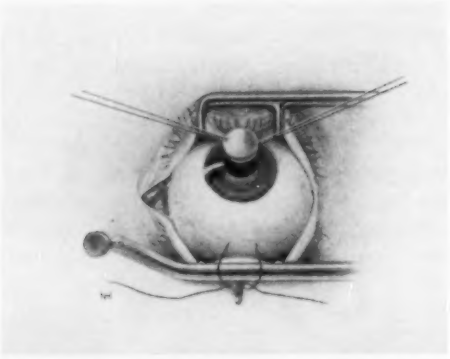

Fig. 7 (Doctor). Donor button is brought into position in the recipient eye and sutured.

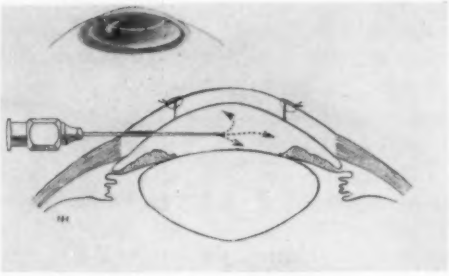

Fig. 8 (Doctor). Air is injected through track incision, using a 30-gauge needle.

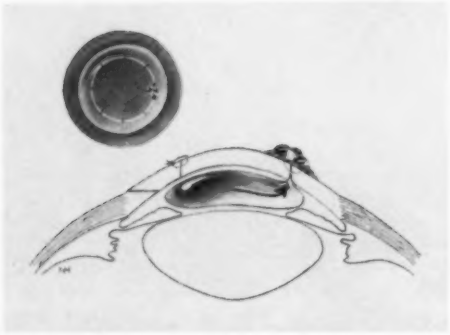

Fig. 9 (Doctor). Air bubbles indicate site of leakage. This should be remedied by extra sutures.

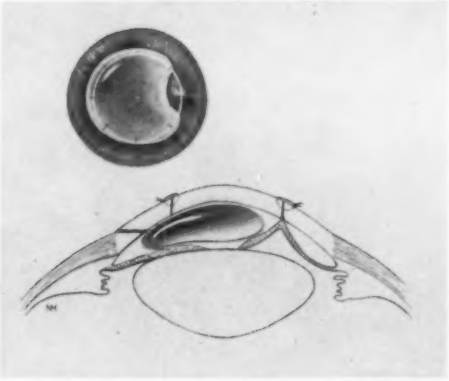

Fig. 10 (Doctor). Air pocketing around sutures indicates iris incarceration which must be remedied.

TABLE 1

SUMMARY OF CASES

Patient	Admission Number	Diagnosis	Size of Graft (mm.)
1. P. K.	242310	Keratoconus	6
2. E. M.	242437	Unclassified dystrophy	6
3. B. F.	242616	Corneal scar	6
4. G. H.	243461	Keratoconus	6
5. G. D.	241762	Corneal scar	6
6. M. M.	248323	Corneal opacity	5
7. S. P.	257050	Keratoconus	6
8. P. M.	251384	Band keratopathy	5
9. L. V.	257030	Keratoconus	6
10. C. B.	252613	Corneal scar	6
11. H. H.	256453	Corneal scar	6
12. A. C.	230073	Keratoconus	6
13. A. C.	230984	Corneal scar	5
14. J. V.	232003	Fuchs' dystrophy	6
15. J. M.	213718	Hydrops	8
16. F. W.	232493	Fuchs' dystrophy	6
17. L. P.	233587	Keratoconus	6
18. A. C.	233582	Corneal scar	5
19. K. M.	235485	Fuchs' dystrophy*	6
20. J. V.	236202	Fuchs' dystrophy	6
21. T. P.	236417	Interstitial keratitis	6
22. A. H.	237113	Hydrops	9 (square)
23. M. K.	237306	Keratoconus	6
24. T. P.	231897	Interstitial keratitis	6
25. B. B.	230209	Fuchs' dystrophy	6

* The one case with synechia formation.

fifth, the track may be used before the trephination to inject air or saline to build up tension in a soft eye.

In a small series of 25 cases (table 1), there has been only one case with synechia formation; this seems to have been due to the patient's vomiting immediately after leaving the operating room. There has been no case of iris or lens trauma. Although producing a soft eye due to loss of aqueous with the initial incision was of concern, this occurred only once and was easily remedied by injecting saline prior to the trephination.

SUMMARY

In a series of 25 penetrating keratoplasties, a preliminary incision with a Ziegler knife has been used as a track through which air may be injected into the anterior chamber postoperatively. This method seems safe, practical, and affords air-tight closure of the wound margins, thus helping to reduce the incidence of anterior synechias.

252 East State Street.

REFERENCES

1. Castroviejo, R.: Am. J. Ophth., **31**:1375 (Nov.) 1948.
2. Fine, M.: Arch. Ophth., **53**:13 (Jan.) 1955.
3. Leahey, B.: Am. J. Ophth., **46**:541 (Oct.) 1958.
4. Paton, R. T.: Arch. Ophth., **52**:871 (Dec.) 1954.
5. Doctor, D. W.: Unpublished data.
6. Chandler, P. A.: Arch. Ophth., **47**:695, 1952.

PREPARATION OF TRITIATED ACETAZOLAMIDE BY THE WILZBACH TECHNIQUE*

FRANK W. NEWELL, M.D.
SEYMOUR B. GOREN, M.D.
AND
WILLIAM L. CAMPBELL, B.S.
Chicago, Illinois

Inasmuch as acetazolamide (Diamox, Lederle) has been of unusual value in the study of intraocular fluid dynamics and ocular and renal physiology, it is believed that a preliminary report regarding a method of labelling the compound with tritium (hydrogen-3) is justified. In an earlier communication, the localization of acetazolamide labelled with sulfur-35 was reported by Goren, Newell, and O'Toole.[1] They found that the ciliary processes, iris and inner layers of the retina contained the highest concentrations of the drug. However, sulfur-35, which is a relatively strong beta particle emitter, precluded an autoradiographic localization of the compound on an intracellular level.

The difficulties inherent in excess scatter arising from strong beta emitters may be eliminated by the use of weak beta particles

* From the Department of Surgery (Ophthalmology), The University of Chicago. This investigation was supported in part by a research grant B-1515, from the National Institute of Neurological Diseases and Blindness of the National Institutes of Health, Public Health Service, Bethesda, Maryland.

from tritium. Additionally, the 12.4 years half-life of tritium allows the use of techniques which cannot be applied with sulfur-35 which has a half-life of 87.1 days. It thus became desirable to prepare acetazolamide labelled with tritium.

Method

One gm. of purified nonradioactive acetazolamide was exposed to 3.0 curies of tritium gas according to the Wilzbach technique at 27°C. and 0.39 atmospheres by the New England Nuclear Corporation. The resultant compound was placed repeatedly in 75 cc. of absolute ethanol and the solvent removed at room temperature in vacuum until its specific activity remained constant. Boiling dilute ammonium hydroxide was then added to the crude compound until the solution was clear. Decolorizing carbon was placed into the solution, the mixture boiled for three minutes, and then filtered. Concentrated hydrochloric acid was added to the clear filtrate until a white precipitate formed.

The compound was allowed to cool to room temperature and was then placed in a refrigerator for 10 hours. Following this, it was filtered and the crystals collected. Minimal amounts of boiling water were then added until the crystals were dissolved. The solution was then allowed to cool slowly to room temperature and was then refiltered. These procedures were repeated until the specific activity remained constant.

Chromatograms were performed in both butanol-water and methyl-ethyl-ketone-water systems to ascertain the radioactive purity of the drug. A single band was present on the final chromatograms. Additionally the chromatographic rate of flow and melting point of the labelled drug corresponded to that of nonradioactive acetazolamide (258°C.).[2]

The specific activity as determined with a scintillation counter was 85 μc. per mg. (18.8 mc. per millimole). The compound appears to be stable. The yield was 50 percent.

Summary

A simple and inexpensive method for the preparation of tritium-labeled acetazolamide has been developed. It is believed that this compound will be a valuable tool in the study of intraocular fluid dynamics.

950 East 59th Street (37).

References

1. Goren, S. B., Newell, F. W., and O'Toole, J. J.: The localization of Diamox-S[35] in the rabbit eye. Am. J. Ophth., in press. (Abstract Am. J. Ophth., **50**:169, 1960.)
2. Roblin, R. O., Jr., and Clapp, J. W.: The preparation of heterocyclic sulfonamides. J. Am. Chem. Soc., **72**:4890, 1950.

GLAUCOMA WITH KRUKENBERG'S SPINDLES*

Y. Dayal, D.O.M.S.
Aligarh, India

The occurrence of glaucoma with Krukenberg's spindles is an infrequent but definite clinical entity. The condition is associated with a marked deposition of pigment in the trabecular space with degeneration of the pigment epithelium of the iris and ciliary body.

Case report

A woman (fig. 1), aged 42 years, was admitted to the hospital on April 7, 1958, complaining of intermittent headache with gradual deterioration of vision of both eyes for the last year. There was a history of haloes around lights on three or four occasions during the past four years. There was no history of congestion of the eyes at any time.

Examination. Her visual acuity was: R.E., 6/18; L.E., 6/24, with the following correction: R.E., 1.5D. sph. ⊃ +0.75D. cyl. ax. 90°; L.E., −2.5D. sph. ⊃ +1.0D. cyl. ax. 90°. Anterior chambers were normal. Iris was grossly depigmented, leaving only a circumscribed fringe of pigment in the pupillary zone. Slitlamp examination revealed a good amount of pigment dispersion. Pigment granules were deposited on the anterior iris surface,

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* From the Gandhi Eye Hospital and Muslim University Institute of Ophthalmology. I am grateful to the Chief Medical Officer, Gandhi Eye Hospital, for permission to undertake this study and to publish this paper.

mainly condensed near the pupillary margin, and on the posterior surface of the cornea in the form of a typical Krukenberg's spindle (fig. 2). Gonioscopy revealed narrow angles with a very dense trabecular pigment ring in either eye. The lens showed early nuclear sclerosis. The fundus in both eyes was tasselated with small temporal crescents and the left disc also had an early glaucomatous cupping. Perimetry revealed enlargement of the blindspot with marked peripheral contraction L > R. The tension was: R.E., 38 mm. Hg, L.E., 39 mm. Hg (Schiøtz). Tonography indicated a glaucomatous coefficient of outflow in either eye (fig. 3).

The patient appeared to be in good general health without any evidence of vascular sclerosis. Blood pressure was 138/80 mm. Hg. Capillary fragility test, blood, and urine were all within normal limits.

Treatment. She was put on miotics (two-percent Pilocarpine nitras) four times daily in each eye for a week, after which the tension was reduced to: R.E., 26 mm. Hg; L.E., 28 mm. Hg. Tension again went up to 32 mm. Hg (Schiøtz) on cessation of the therapy. Ultimately trephination was done, with subsequent normalization of the tension.

Discussion

Sugar (1940) reported the first case of this nature and later (with Barbour, 1949) added a few more. He designated the condition as pigmentary glaucoma and classified it under the category of secondary glaucoma. He believed that marked deposition of pigment in the trabecular spaces may in itself cause increased intraocular pressure. Calhoun (1952), reporting a few more cases, concluded that there is little evidence that the pigment deposit alone can produce glaucoma.

Most of the cases reported so far were in young men. The present case is unusual in that respect. If the senile process in ocular tissues is studied, a few uveal pigment granules are seen on the back of the cornea in aged people. In myopes and mostly females (Duke-Elder, 1938), this tendency is further augmented so that innumerable particles

Fig. 1 (Dayal). Photograph of patient.

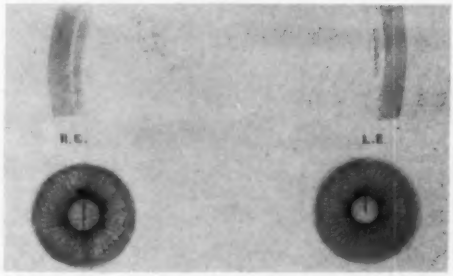

Fig. 2 (Dayal). Drawing of Krukenberg's spindle.

cling to the endothelium. This becomes all the more apparent after uveal inflammation or uveal atrophy so commonly resulting from glaucoma. These granules tend to be aggregated by convection currents vertically mostly into the axial area on the back of the cornea, assuming rough spindle-shaped forms, which are known as Krukenberg's spindles. I feel that this same pigment also reaches the angles of the anterior chamber and clogs the trabecular spaces, causing further embarrassment to the aqueous outflow. Some granules may also be deposited on the anterior surface of the lens and zonules.

It seems quite likely that these cases are actually cases of simple glaucoma in which this process of degeneration and dispersion of the uveal pigment is more marked, giving the slightly changed clinical picture of heavily pigmented trabeculae and Krukenberg's spindles. It would seem, therefore, that these cases should be classified as a special variety of chronic simple glaucoma rather than a

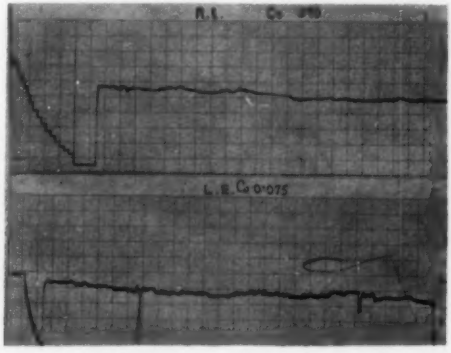

Fig. 3 (Dayal). Tonograms.

type of classical secondary glaucoma. The dense pigmentation of the angles alone is less likely to result in glaucoma, unless there is an associated basic defect in the eyes, as exists in cases of primary glaucoma. The treatment, therefore, should be as for primary simple glaucoma—miotics as long as possible and surgery if the tension remains uncontrolled.

Gandhi Eye Hospital.

REFERENCES

Calhoun, F. P., Jr.: Tr. Am. Ophth. Soc., **50**:103, 1952.
Duke-Elder, S.: Textbook of Ophthalmology. London, Kimpton, 1939, v. 2, p. 2036.
Sugar, H. S.: Am. J. Ophth., **23**:853, 1940.
Sugar, H. S., and Barbour, F. A.: Am. J. Ophth., **32**:90, 1949.
Sugar, H. S.: The Glaucomas. St. Louis, Mosby, 1957, ed. 2, p. 331.

POTENTIAL ANTIBACTERIAL PROPERTIES OF THE HUMAN VITREOUS

A. HAGEDOORN, M.D.
AND
E. R. MAAS
Amsterdam, Holland

According to Shafer and Bussey,[1, 2] and Reed and Tushingham,[3] the human vitreous has antibacterial properties. These authors maintain that this is exclusive to the human vitreous. No antibacterial property was found in dog or rabbit.

In eyes used for corneal transplantation or after enucleation we confirmed the antibacterial properties of the human vitreous. Later, however, we realized that in all these cases the human eye had been in contact with antibiotics. As in most hospitals, it proved rather difficult to obtain eyes of which we could say with certainty that there had been no contact with antibiotics. This was especially true of eyes enucleated for corneal transplantation.

Recently an exenteration of the orbit was performed for meningioma of the sheath of the optic nerve. The patient received no antibiotic treatment either before or during the operation. Immediately after the operation the eye was opened and the vitreous extracted. The results of the ensuing experiments are shown in the illustrations.

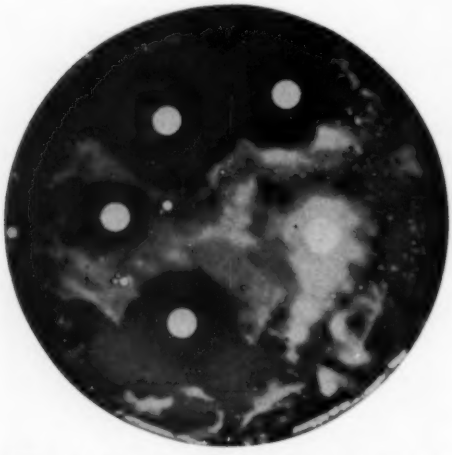

Fig. 1 (Hagedoorn and Maas). A hemolytic streptococcus on a blood-agar plate. At the right is the pit filled with vitreous, on the bottom a pellet impregnated with penicillin, to the left streptomycin, followed by chloramphenicol and terramycin.

Fig. 2 (Hagedoorn and Maas). An agar plate contaminated with a Staph. aureus nonsensitive to penicillin and streptomycin. At the center is the pit with vitreous, at the bottom to the right penicillin, to the left streptomycin and beyond chloramphenicol and terramycin.

Fig. 3 (Hagedoorn and Maas). B. subtilis on an agar plate. To the right is the vitreous, at the bottom penicillin and beyond to the left, streptomycin, chloramphenicol, and terramycin.

The usual plates were used, with pits of six-mm. diameter, depth two mm. (figs. 1 to 4).

Since Shafer used 0.2 ml., the same amount of vitreous was used in another set of experiments, so that the pits were oversaturated and the surface suffused two or three mm. around the pit. Where the vitreous covered the surface, bacterial growth was unimpaired (fig. 5). We also made deposits of 16 mm. (normal six mm.) so that the pit could contain the whole amount of vitreous without overflowing. A photograph of both techniques is reproduced here on one plate (fig. 5).

Fig. 4 (Hagedoorn and Maas). A Pseudomonas aeruginosa on an agar plate. The pit is filled up with vitreous to the right, at the bottom, a bit to the left, penicillin and beyond streptomycin, chloramphenicol, and terramycin.

Fig. 5 (Hagedoorn and Maas). Agar plate contaminated with Staph. aureus. On the top to the right, a pit six mm. in diameter is filled with vitreous, overflowing the surrounding surface. To the right a 16-mm. diameter pit is filled with vitreous, and beyond penicillin, streptomycin, and terramycin.

There is no doubt that, in this particular case, the human vitreous had no antibacterial properties but reacted like the vitreous in dog or rabbit.

Summary

Human vitreous from one eye showed no antibacterial properties. The question is raised whether at least part of the findings mentioned by others might not be due to contact with antibiotics.

Wilhelmina Gasthuis.

References

1. Shafer, D. M., and Bussey, J. L.: AMA Arch. Ophth., **60**:255, 1958.
2. Bussey, J. L., Shafer, D. M., and Hughes, I. A.: AMA Arch. Ophth., **61**:233, 1959.
3. Reed, H., and Tushingham, G.: AMA Arch. Ophth., **62**:780, 1959.

OPHTHALMIC RESEARCH

EDITED BY FRANK W. NEWELL, M.D.
950 East 59th Street, *Chicago 37, Illinois*

Abstracts of papers presented at the meeting of the Western Section of the Association for Research in Ophthalmology, Inc., Stanford University School of Medicine
Palo Alto, California, November 17 and 18, 1960.
DANIEL G. VAUGHAN, *Section Secretary*

The effect of restricted visual space on the primate eye. Francis A. Young, Ph.D., Department of Psychology, Washington State University, Pullman, Washington.

Nine randomly selected Macaca nemestrina (pigtail) monkeys were placed in restraining chairs inside individual translucent hoods which served to isolate the animal from the visual environment and restricted his visual space to a maximum distance of 20 inches and an average distance of 15 inches from the eyes. The static refraction under cycloplegia of the experimental animals during six months under the hoods changed significantly toward myopia when compared with their initial refraction and with that of the control group (eight animals) which remained in the living-cage room. There was no significant difference between the two groups initially. The rate of change decreased toward the end of the experimental period. A slight regression occurred in some of the animals during the period of a year following removal from the experimental situation though none returned to the original refractive state.

Corneal bending and buckling and the oil-can effect in tonometry. Elwin Marg, R. Stuart Mackay, and Raymond Oechsli, School of Optometry, University of California, Berkeley.

The curve obtained from the application of our new tonometer is examined in the light of two hypotheses. One states that the flattened cornea demonstrates an oil-can or buckling effect; the other states that the main features of the curve are caused by corneal rigidity or stiffness. Both effects can be exhibited under certain conditions on a rubber balloon eye model. A critical experiment clearly shows that corneal rigidity rather than buckling is responsible for the crest and trough of the curve. Thus the height of the first crest above the trough is a measure of corneal rigidity; the first trough above the baseline is the intraocular pressure, free of the sizeable errors which invalidate other tonometers. The central maximum is the pressure to which the eye is artificially raised during applanation; and the second trough and crest are the intraocular pressure and corneal rigidity after the artificial or induced rise.

Lacrimal gamma zone changes following colchicine. Olive F. Erickson, M.D., Rachel Hatlen and Margaret H. Berg, Presbyterian Medical Center, Stanford University Medical School, San Francisco and Palo Alto.

An abnormal protein which frequently appears in lacrimal protein patterns from patients who have eye complaints has a mobility rate of gamma globulin. A high tear gamma occurs frequently in allergic conditions and in collagen diseases. We have also found a double globulin zone peak in children who had chronically infected cervical glands. When this is present, it seems to block secretion of lysozyme and even in those who have an adequate amount of the enzyme, lysozyme action seems to be inhibited.

A patient, suspected of having gout, was given a colchicine lacrimal-protein drug study. Control lacrimal specimens were taken, colchicine was given by mouth and an hour later the Schirmer test was repeated. The superimposed lacrimal protein patterns showed a decreased gamma zone protein concentration. The decrease, compared to the original value, was 85 percent on the right and 70 percent on the left. This patient who had been complaining for months, was temporarily relieved of all her eye symptoms. Anemia, due to blood loss from uterine fibroids, was later found to be a cause of her illness.

A high gamma zone globulin is a basic problem in lacrimal research. We therefore tried colchicine on eight more patients who had high gamma zone proteins. None of the others were as dramatic as the first one. Of 18 specimens done, the percentage went down in 10 and up in eight. Decreasing high gamma zone protein in tears is not a specific action of colchicine. One of our regitine (sympathetic blocking agent) drug studies was similar to the first colchicine study.

Colchicine in individual cases has specifically decreased the gamma zone protein in lacrimal protein patterns. This action, however, is not consistent.

Rheology of the human sclera. Roger St. Helen and William K. McEwen, Ph.D., Francis I. Proctor Foundation for Research in Ophthalmology, University of California Medical Center, San Francisco.

The reaction of the sclera to stretching is not analogous to the reaction of a simple spring or rubber balloon. Within elastic limits, the stretching

action of the sclera may be resolved into the simultaneous action of three processes. These processes may be related to the action of simple rheologic bodies. One of these is a Hooke body or simple spring; the other two are Maxwell bodies, each being a spring coupled to a dash-pot which gives viscous drag.

Experimental photocoagulation of the filtration angle. H. C. Zweng, M.D., and Milton Flocks, M.D., Stanford University School of Medicine, Department of Surgery (Ophthalmology), Stanford Medical Center, Palo Alto.

Using the photocoagulator of Meyer-Schwickerath the filtration angles of cats, dogs and monkeys have been coagulated through a Koeppe goniolens. This is possible because the greater pigmentation of the angle permits selective absorption by the trabeculae and ciliary body of the bulk of the light energy. Immediately following this procedure the pupil becomes dilated and the tension is markedly lowered. Slitlamp examination showed some cells, mostly pigmented, in the anterior chamber. This cleared in about two weeks. The lowered tension persisted long after the anterior chamber cleared. After several months the tension and pupil tend to return to normal. Histologic preparations demonstrate injury to the trabecular meshwork and portions of the ciliary body in the absence of peripheral anterior synechias. Preliminary tonographic studies were inconclusive.

Isolation of viruses from inclusion conjunctivitis in infants. L. Hanna, J. Zichosch, E. Jawetz, D. G. Vaughan, and P. Thygeson, Department of Microbiology and Proctor Foundation for Research in Ophthalmology, University of California Medical School, San Francisco.

Conjunctival scrapings were obtained from 14 infants, aged one to six weeks, one to 28 days after onset of inclusion conjunctivitis. In each case typical elementary body inclusions within epithelial cells were demonstrable. When these specimens were inoculated into the yolk sacs of embryonated eggs, virus was recovered from three patients. In morphology, infectivity for eggs, behavior toward antibiotics, and so forth, these viruses resembled trachoma viruses isolated in this laboratory. When one of these agents was introduced into the eyes of cynomolgus monkeys and a baboon, an acute conjunctivitis was produced, with extreme hyperemia and bleeding upon light touch, and prominent follicles. Scrapings from the monkey conjunctivas contained many typical inclusion bodies, and the virus was re-isolated in eggs repeatedly.

It is recognized that inclusion conjunctivitis is usually acquired by the infant from the mother's genital tract. Scrapings from the cervices of three of the mothers (including the mother of one infant from whom virus was recovered) were negative or unsatisfactory because of bacterial contamination.

Antibodies in vernal conjunctivitis. Mathea June Allansmith, M.D., Department of Medical Microbiology, Stanford University, Palo Alto.

Antibodies to rye grass were found in the sera of 22 (73 percent) of 30 patients with vernal conjunctivitis by the bis-diazotized benzedine hemagglutination method. Three patients with antibody had received desensitization injections to grass. The antibody was found in 19 (73 percent) of 26 patients with spring hay fever and positive intradermal skin tests to grass used as positive controls—one half of the hay-fever group had been desensitized. No antibody was found in the sera of 60 normal patients used as negative controls.

In the vernal conjunctivitis group, the average age of the 23 children was 8.4 years; the over-all age average was 12.8 years; 25 (83 percent) of the 30 patients were males. Antibody was present in 14 of the 16 with strongly positive intradermal skin tests to grass and in four of the five with weakly or questionably positive skin tests. Three patients with negative skin tests had hemagglutinating antibody to grass—a finding previously unreported in atopic patients. Positive family and personal history of atopic disease (hay fever, asthma, eczema, allergic rhinitis) was found in one half of the patients. The presence or titer of the antibody did not correlate with severity of disease, duration, sex, other allergies, limbal or palpebral type of vernal conjunctivitis, or seasonal variation, but did correlate with positive skin tests.

Vernal conjunctivitis has, in common with the atopic diseases, a young age incidence, local and sometimes blood eosinophilia, frequent personal and family history of allergy and, with hay fever, a marked seasonal variation. The finding of a specific antibody in vernal conjunctivitis, that is also present in an atopic disease but not in normal people, suggests that vernal conjunctivitis is a type of atopic disease.

Immunologic testing in homo-immune uveitis in the guinea pig. Samuel B. Aronson, M.D., and Phyllis Zweigert, Department of Ophthalmology and Francis I. Proctor Foundation for Research in Ophthalmology, University of California, San Francisco.

Clinical and histologic uveitis have been induced in pigmented and albino guinea pigs by immunization with homologous uveal tract in complete Freund adjuvant. The mechanism of homosensitization with the production of a homo-immune antibody has been postulated. In attempting to identify this antibody, multiple skin tests and precipitin tests (agar) were performed.

Pigmented and albino guinea pigs of all experimental groups (experimental uveal tract, spleen control, and adjuvant control) were skin tested before and after immunization with: pigmented guinea pig uveal tract, albino guinea pig uveal tract, guinea pig spleen, pooled guinea pig whole blood. All animals were negative to all skin tests before immunization. After immunization the uveal tract animals had positive skin tests to: pigmented

uveal tract, albino uveal tract, and spleen. (There was no difference between animals which developed uveitis, and animals which did not.) The spleen-controlled animals were positive to: (1) pigmented uveal tract, (2) albino uveal tract, (3) spleen, (4) whole blood. The adjuvant controls remained negative to all skin tests.

Seven experimental uveal tract animals demonstrated precipitin lines on agar diffusion (antigen: pigmented uveal tract). However, these tests were equally divided between those animals with and without uveitis.

In interpreting the skin tests, it would seem that both the uveal tract experimental and spleen control groups were sensitive to an antigen common to both spleen and uveal tract but not present in whole blood. This antigen is probably unrelated to the experimental uveitis, insofar as there was no distinction between animals with uveitis and those without. (Also shown on agar diffusion.) Therefore, it would seem as if there is a common tissue antigen in those tissues tested, which obscures the antigen-antibody reaction related to uveitis production. This would tend to discourage further attempts to localize a uveitis-producing antibody with an impure antigen mixture (homologous uveal tract).

Electrophoretic characteristics of hyaluronidase, subtilin and carbonic anhydrase compared to lacrimal proteins. Olive F. Erickson, M.D., Rachel Hatlen and Margaret H. Berg, Presbyterian Medical Center, Stanford University Medical School, San Francisco, and Palo Alto.

Hyaluronidase, subtilin and carbonic anhydrase are three of the some 550 know enzymes. The actions of these three are consistent with tear constituents. Electrophoresis was done with a phosphate buffer of pH 7.0, barbitol 8.6, and LKB 8.9.

Hyaluronidase mobility lies between gamma globulin and lysozyme in all three buffers. Electrophoretically our "slow lysozyme" could be hyaluronidase. Many patients who do not secrete this protein are troubled with a mucous tear film. Some who have been stimulated by cholinergic drugs to secrete "slow lysozyme" seem to have a more normal tear. Electrophoretically and clinically, "slow lysozyme" could be hyaluronidase.

Subtilin was described by Linderstrom-Lang who found that albumin was altered electrophoretically and microscopically when exposed to enzymes from B-subtilus. In normal tears albumin is different from blood serum albumin. Subtilin did not go into solution readily. A 10-percent solution showed a very small concentration and the major protein band was in the gamma zone.

Carbonic anhydrase was made up into 1.0 and 5.0-percent solutions and electrophoresis studies were done with the same buffer solutions. Large concentrations overlapped both gamma and beta zones. The center of the peak in all three buffers was about midway between gamma and beta and a second small peak at about alpha one. Electrophoretically carbonic anhydrase could be present in tears. Lacrimal proteins in this zone are particularly increased in glaucoma patients who still have evidence of lacrimal proteins. Many patients with glaucoma, however, have sicca patterns. One of the tests for carbonic anhydrase is a shift in pH. Clinically the pH 7.2 to 8.8 Schirmer test paper shows a greater pH shift in the patients who have only conjunctival secretions. Hyaluronidase, subtilin and carbonic anhydrase show mobility rates that are found in lacrimal secretions. Further studies are warranted to identify tear film proteins to confirm or rule out the presence of these important enzymes.

A study of cross-eyed Siamese cats. Jane E. Hyde, Ph.D., Department of Physiology, University of California Medical Center, Los Angeles.

In three Siamese cats with demonstrated constant concomitant strabismus, terminal experiments with electrical stimulation in encephale isole preparations revealed markedly increased convergence in response to bilateral occipital cortical stimulation. In contrast, five non-Siamese cats and one Siamese with intermittent cross-eyes, similarly stimulated, yielded conjugate ocular movement to a vertical position with no convergence. Other evidences of innervational abnormality were detected in the cross-eyed cats by stimulation of brainstem areas. No abnormality in size of extraocular muscles or nerves could be seen. Histologic examination revealed normal development of abducens and oculomotor nuclei. Two of the three cross-eyed cats had additional mechanical restriction to abduction, revealed in part by pitting of the infraorbital plate; such defect was not seen in the third cross-eyed or in noncross-eyed Siamese or non-Siamese cats.

Thus, anatomic defects of orbital structures were not consistently associated with innervational or neurogenic abnormalities observed in strabismic Siamese cats.

Accommodation and applanation tonometry. Mansour F. Armaly, M.D., and Melvin L. Rubin, M.D., Department of Ophthalmology, State University of Iowa, Iowa City.

The applanation tonometer of Goldmann was used to investigate the effect of accommodation on intraocular pressure. A special fixation apparatus was used which could control the accommodative stimulus and could provide a check on sustained accommodation of the subject. Ten subjects were used: five, aged 20 to 25 years, and five, aged 45 to 55 years. In all experiments one eye was used consistently for fixation; the other eye for pressure measurements. Applanation tonometric readings were made on the non-fixing eye at intervals of one minute and continuing for at least 20 minutes. The effect of the following conditions on intraocular pressure was explored: (1) Complete relaxation, (2) controlled, graded accommodation, (3) the change in fixation from distance (18 feet) to the near fixation light of the Haag-Streit slit-

lamp, (4) the modification of the effect of the above conditions by age, and three pharmacologic agents: 10-percent phenylephrine, 1.0-percent Cyclogyl, and 1.0-percent atropine.

The results indicate that there is a definite reduction of intraocular pressure associated with accommodation in all subjects; the reduction averages 3.6 mm. Hg. In the younger age group, the intraocular pressure reduction was significantly greater in magnitude and shorter in its time constant than in the older age group. This decrease in intraocular pressure is exactly comparable to the drop occurring on use of the near fixation light. This intraocular pressure response is not affected in any way by 10-percent neosynephrine and is essentially completely eliminated by the cycloplegics used.

During complete relaxation of accommodation for distance fixation, repeated applanation readings reveal no effect of tonometry itself on the intraocular pressure. In every case the first reading was slightly but significantly higher on the first reading than in all subsequent readings. The difference between the first and the following readings during relaxation was completely eliminated by parasympatholytic drugs.

The results must be explained by the effect of accommodation on the various parameters determining the steady-state pressure (that is, episcleral venous pressure, outflow facility, and/or inflow rate) and not by intra- or extraocular changes of a transitory nature (as extraocular muscles or intraocular blood volume).

Ophthalmic Miniature

Dr. Bigger exhibited to the meeting two rabbits, one of which had been treated with the bichloride of mercury, the other had been left to nature; in the latter case nine months had elapsed since the performance of the operation (corneal transplantation); in the former, only ten weeks. These animals, as has been already stated, were the subject of his first and last experiments at home, and were calculated to show the improvement made in the mode of performing the operation. The difference between them was very remarkable. The eye to which the bichloride of mercury had been applied, seemed to possess a distinct and perfect power of vision; and there was nothing to indicate the existence of a transplanted cornea, but a slight line in the situation of the cicatrix, and some degree of conicality in the cornea. To enable himself and the meeting to judge more accurately of the power of vision in this animal, Dr. Bigger had destroyed the opposite eye. In the other animal the vision was very imperfect, not so much from opacity of the cornea, as from the condition of the iris and the deeper-seated tissues of the eye. The cixatrix in this case was large, dense, and of a somewhat triangular form.

Dr. Bigger on "Transplanting of the cornea,"
The Dublin Journal of Medical Science, 1837.

SOCIETY PROCEEDINGS

EDITED BY DONALD M. LYLE, M.D.

BROOKLYN OPHTHALMOLOGICAL SOCIETY

January 25, 1960

ANTERIOR CHAMBER LENS

DR. WALTER J. GEERAETS (Richmond, Virginia): The historical development of intraocular plastic lenses as substitution for the normal lens in unilateral aphakia was demonstrated. A statistical analysis on the results with different types of anterior chamber lenses, as well as conclusions, contraindications, and implantation techniques of several continental ophthalmologists were reported and compared with our observations and findings. A summary on animal experiments data on selection of plastic resins and their intraocular tolerability was given. In this connection, it was pointed out that while methyl-methacrylate is relatively well tolerated by the body tissues, silicone appears to be the most inert material and, in addition, offers excellent optical qualities. Of the plastic materials for elastic support of the lenticulus, Supramid and Teflon gave the least tissue reaction.

Two possible theories were given for the development of corneal dystrophies after anterior chamber lens implantation: (1) a mechanical theory, in which either the lenticulus or the supporting mounts are in contact with corneal endothelium, thus causing dystrophy; and (2) a chemical theory in which late corneal dystrophy might be caused by degradation products and slow elimination of disinfectants and catalysts from the acrylic material. If corneal dystrophy develops, it may be reversible after early removal of the lens. The necessity of a careful selection of cases for anterior chamber lens implantation was stressed; it may be the most important factor in determining a successful outcome.

The following contraindications for the use of an intraocular plastic lens were mentioned: (1) primary or secondary glaucoma; (2) shallow anterior chamber; (3) fixed pupil due to posterior synechias; (4) vitreous in the anterior chamber; (5) nongranulomatous or granulomatous uveitis; (6) predisposition to sympathetic ophthalmia; (7) any fundus pathologic change; (8) corneal pathologic findings.

The use of anterior chamber lenses in myopia, anisometropia and after routine cataract extraction was regarded as not justified as long as other simpler and safer methods for correction are available.

An operative technique for the implantation of anterior chamber lenses with elastic supporting mounts was described and demonstrated in slides and a movie. It was strongly suggested that the cataract extraction be performed and the plastic lens be implanted in a two-stage procedure, that is, the anterior chamber lens should not be implanted for one to two months after the eye has become completely quiet following cataract extraction. Dilatation of the pupil, antibiotics, and systemic steroids were recommended in the immediate postoperative management.

From observations over a period of three years, it was concluded that, at the present time and in selected cases, the anterior chamber lens seems to offer a promising solution for the problem of monocular aphakia.

CONTACT LENSES

DR. S. S. VAN WIEMOKLY (Morristown, New Jersey): Within recent years new microtype contact lenses have reached the state of development where they can be regarded as practical ophthalmic appliances. Ophthalmologists as a group have until recently been loathe to fit and dispense contact lenses for many reasons. This attitude can no longer be countenanced if proper eye care is to remain in the hands of physicians.

Because of previous fitting difficulties, there were many false impressions of the impracticalities in fitting procedures in the hands of the average ophthalmologist. The most important of these were discussed.

A description was given of the technical aspects of the new types of lenses and the reasons for their being better tolerated. All technical aspects of the lenses are readily available in the current literature of the lens manufacturers.

It was noted that four things are important in ordering contact lenses: (1) the refraction, (2) the keratometric readings, (3) the corneal size, (4) the pupillary size.

The importance of proper screening of patients was discussed. Such screening includes motivational drive, age, sex and pathologic conditions. How to order lenses and the economic factors involved were discussed, as were the philosophy of price structure, cost, and insurance problems. The various aspects of follow-up care were elaborated. The handling of various types of symptomatology, such as tight lenses, loose lenses, and so forth, was discussed. Various practical techniques to obviate these symptoms were outlined. Bifocal contact lenses and their present status were discussed briefly.

Nicholas P. Tantillo,
Secretary.

NEW ENGLAND OPHTHALMOLOGICAL SOCIETY

451st meeting, December 16, 1959

DR. BRENDAN LEAHEY, *presiding*

SURGERY OF VERTICAL MUSCLES

DR. HUNTER H. ROMAINE: Ophthalmologists were urged to consider a vertical defect on a systemic as well as on a local basis and to do a sufficient examination to enable making a satisfactory diagnosis. Treatment should be conservative whenever possible and for as long as the therapy is effective, and surgery should be undertaken when it is the only course. Postoperative therapy and the follow-up care are as important as the procedure itself. Ophthalmologists should not refrain from doing vertical muscle surgery because of insufficient knowledge but should learn more about the vertical physio-anatomy and physiology and then undertake the procedures.

Discussion. DR. LIEBMAN: How can you estimate what the given effect will be from a recession of an inferior oblique?

DR. ROMAINE: One can expect about as much as from similar surgery on other muscles. The degree of hyperphoria should be evaluated from the eyes-front position, particularly if the inferior oblique is suspected. I recede a mm. for a degree in so far as possible. It is not an exact science. One should not recede the inferior oblique more than 9.0 to 10 mm.

DR. LEAHY: I have never seen an overcorrection from a myectomy of an inferior oblique.

DR. ROMAINE: I do not get enough effect from a myectomy so I prefer to recess the muscle actively rather than passively.

DR. H. ALLEN: Have you tried protecting the sclera with Silicone?

DR. ROMAINE: Silicone may not stay in position and sewing it into position increases the scarring.

DR. ROSS: What are the dangers of vertical muscle surgery?

DR. ROMAINE: One chief danger involves the levator when operating upon the superior rectus. A resection of the superior rectus of more than 3.0 or 4.0 mm. can get one into trouble. The levator may become involved and ptosis will result.

IMPORTANCE OF CHOROIDAL DETACHMENT IN FUNDUS DIAGNOSIS

DR. SCHEPENS: Subchoroidal fluid may be exudate, transudate or blood. The fundus picture is characteristic. The choroid and retina are elevated. The choroidal detachment has a darker and pinker color than that of retinal detachment and its surface is smooth and

fixed. The ora serrata is elevated by the detachment and becomes visible without pressure on the globe. In the four areas of the vortex veins the choroid remains held down. Transillumination is usually not obstructed except in the case of whole blood beneath the choroid. The usual course indicates a rapid development initially and then, after a few days, a gradual improvement. Concentric, fine, black lines resembling "high water marks" are a sign of improvement. Sensitivity to light is reduced in these areas and the field is depressed.

A differential diagnosis between retinal detachment and the presence of a solid tumor may be difficult. In retinal detachment one will find retinal breaks and there will be retinal folds with movement of the retina as the eye moves. Fixed folds of the equatorial type or star-shaped type are seen chiefly with retinal detachment. When a tumor exists there will be mottling and darkening of the choroidal pigmentary pattern. The shape may be globular. Transillumination usually is positive with tumor but not always. One should beware of a dark shadow when a choroidal detachment exists with an accumulation of blood. The P^{32} test can help in the differential diagnosis.

The intraocular pressure is usually low in choroidal detachments. Dr. Schepens believes that the capillary bed in some eyes cannot withstand the sudden drop of pressure when the eye is opened. The result is fluid in the subchoroidal space. Choroidal detachment can lead to glaucoma. The fluid in the suprachoroidal space dissects forward up to the scleral spur all around the globe, and the angle may become closed if not treated early.

Therapy should be conservative. Dr. Schepens uses steroids to reduce the permeability of the capillaries, attempting to stop the influx of fluid into the eye. Only in extreme cases of choroidal detachment does he urge surgery. A posterior sclerotomy with a guard suture in the sclera is performed and the fluid is let out slowly. In extreme hypotension a circling tube may be used to reform the globe and increase the intraocular pressure.

Where angle closure has been noted, Dr. Schepens does not wait until the pressure is markedly elevated. If there is no effect from medication, a paracentesis followed by a scleral incision over the ciliary body and the release of a few drops of fluid is recommended. The anterior chamber is then deepened with saline to establish the angle.

Choroidal detachment may be seen in buckling surgery for retinal detachments. If it is not recognized as such, the outcome can be fatal to the eye. It is usually noted in an area not the site of maximum detachment surgery. Further surgery would just increase exudation into the subchoroidal space.

Dr. Schepens described a condition which he called extensive uveitis of an exudative type where there are no retinal breaks, a retinal detachment, a choroidal detachment, but no signs of uveitis. The protein and cerebrospinal pressure have been elevated in these cases. On recovery retinal scarring is minimal.

DR. CHANDLER: In the cases of flat or shallow anterior chambers after intraocular surgery, I interfere no later than the fifth day, draining off the subchoroidal fluid and putting air into the anterior chamber. I suggest that the hypotony in detachment of the choroid can be, in part, due to complete cessation of aqueous formation. Very flat choroidal detachments may not be diagnosed with the ophthalmoscope.

DR. SCHEPENS: I wish to point out that my paper was presented from the viewpoint of retinal detachment surgery. We do not interfere with the anterior chamber in retinal surgery and therefore cannot consider leakage of the wound a factor as suggested by Dr. Verhoeff. A leaking wound sets up a vicious cycle which results from the persistent hypotony. If you stop the leak, you will build up pressure and the choroid may be pushed back.

Vitreous hemorrhages

Dr. Robert J. Brockhurst: Vitreous hemorrhages may have the following etiology: a retinal tear, trauma, disciform degeneration, diabetes, hypertension, arteriosclerosis, blood dyscrasias, intraocular tumor, and the formation of abnormal blood vessels growing on the surface of the retina and into the vitreous. The latter group will include retrolental fibroplasia, diabetic retinopathy, sickle-cell hemoglobin-C disease and vascular occlusion. Periphlebitis as in Eales' disease or the healing process of a posterior perforating wound can be the cause of abnormal vessels which result in vitreous hemorrhages.

Dr. Brockhurst suggested a surgical treatment, using diathermy when the disease is not extensive, the vitreous is sufficiently clear to see the source of the hemorrhage, and when the disease is not progressive but has a fair prognosis. The surgery demands good exposure of the area and fundus visualization. Too extensive diathermy may produce a secondary effusion of fluid.

Principles of lamellar keratoplasty

Dr. Claes H. Dohlman: Lamellar corneal resection is a safer procedure than penetrating keratoplasty. It is more suitable for superficial and peripheral opacities. Fewer hospitalization days are required and the immune reactions are much less. Lamellar keratoplasty is indicated in long-standing and recurrent infectious disease of the cornea, degenerative changes of the cornea, and perforation of the cornea.

Dr. William Stone: Lamellar keratoplasty is most useful as a preparatory graft for penetrating keratoplasties, especially where there is marked vascularization. Beta radiation inhibits the smaller vessels prior to surgery. The electric keratome advised by Castroviejo results in a smoother donor graft and less scarring at the interface. Slitlamp dissection enables one to go more deeply beyond the area of scarring without penetrating.

Dr. Leahy: It is important to get rid of the vessels by beta radiation. New vessels in lamellar keratoplasty may go into the interface. It has been noted in a penetrating type graft that the new vessels stop at the junction.

Dr. Sullivan: A case of bullous keratopathy in an aphakic eye was treated with lamellar keratoplasty but the relief was only temporary. There was a recurrence of the initial disease.

Ocular diagnosis of amyloidosis

Dr. Herbert E. Kaufman: Several cases of amyloidosis, which were characterized by a familial tendency, developed characteristic dense vitreous opacities. The disease onset was slow and characterized by periphlebitis and deposits of whitish material around the vessels of the retina. The opacities gradually developed in the vitreous and vision failed. The amyloid was laid down in an acellular portion of the vitreous, apparently coming from the blood stream, and was deposited as a meshwork. The cases described were not noted to have prior vitreous hemorrhages. Amyloid vitreous predominates in the familial form of primary amyloidosis. In reply to Dr. Verhoeff's question if all cases of amyloidosis developed this condition, Dr. Kaufman indicated that the percentage was extremely small.

D. Robert Alpert,
Recorder.

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CORTICOSTEROIDS FOR INFECTIONS*

Why corticosteroids sometimes exert a profoundly harmful effect on the course of an infection is undecided. The cause can hardly be a stimulant effect on the growth of the infective agent, for this would imply a similar metabolic response by such diverse micro-organisms as fungi, protozoa, bacteria, rickettsiae, and viruses, all of which have been shown to be affected by corticosteroids; and if this were indeed the case the principle would certainly have been adopted in diagnostic bacteriology for culturing organisms more speedily. It is likelier that the infective

Reprinted from *The Lancet,* October 22, 1960, pp. 913-914.

agent gains a firmer hold and spreads because corticosteroids suppress the host defense mechanisms by affecting either circulating antibody or the cells themselves. Cortisone interferes with the rise in titer of circulating antibody but does not alter the rate at which administered antibody disappears.[1] This suggests impairment of antibody synthesis—an explanation which can hardly account for the clinical changes which may take place within a day of starting to administer steroids, or for the increased virus multiplication in cortisone-treated chick embryos devoid of antibody.[2] Action at cellular level is more probable, and would explain the well-known anti-inflammatory effect of cortisone not only in infections but also in collagen disorders and hypersensitivity reactions. By means of the rabbit-ear chamber technique, Ebert and Wissler[3] demonstrated that cortisone fundamentally alters the vascular and cellular factors in inflammation. Capillary and arteriolar tone is increased, endothelial swelling is reduced, permeability to plasma-proteins is diminished, and the cells in the inflammatory exudate are changed. While these modifications may be beneficial in collagen or hypersensitivity disorders, they can contribute adversely to inflammation due to infection, by preventing adequate phagocytosis, causing further necrosis or caseation, and hindering the normal development of granulation tissue and of healing.

Some would regard these dangers as sufficient to rule out the use of corticosteroids in any infection; and this would be a sound policy were it not that nowadays increasing numbers of patients are already receiving lengthy courses of corticosteroids for other reasons. When these patients contract infections, corticosteroids need to be given in increased dosage rather than discontinued. Skanse and Miörner,[4] for example, showed that the mortality from Asian influenza in Malmö was highest among those with uncontrolled adrenocortical disease. Thus no absolute prohibition on the use of corticosteroids in the management of infections is feasible. Furthermore, paradoxical though it may seem, the patient with Addison's disease who used to be susceptible to infection is now well controlled and free from infection despite continuous treatment with steroids. Moreover in the past decade the deliberate use of these potentially dangerous drugs in overwhelming infections, unassociated with Addison's disease, has been found to result sometimes in prompt and dramatic improvement which persists long enough for antibiotics to take effect. "Buying time"[5] in this way seems justifiable when death is the almost certain alternative. For the successful management of adrenal failure associated with fulminating meningococcal infections, early intravenous administration of hydrocortisone, besides sulfonamides, is essential. A commoner problem is to decide when a drug of the cortisone group should be combined with sulfonamides in the therapy of the less malignant meningococcal infections. Kinsell and Jahn[6] recommended routine combined therapy for all patients with meningococcal septicemia, but Lepper and Spies[7] were unable to confirm that such a regime had definite advantages in septicemic patients with or without meningococcal meningitis. The sulfonamides, administered intravenously as well as orally, are usually sufficient; but the use of steroids in addition should be considered if signs of impending adrenal failure appear.

Corticosteroids have rapidly relieved fever and toxemia in brucellosis,[8] typhoid fever[9,10] and Rocky Mountain spotted fever;[11] and carefully controlled trials have shown a similar pattern of response in pneumococcal pneumonia.[12,13] Wagner et al.[12] compared the course in 61 penicillin-treated pneumococcal pneumonias with that in 52 patients who also had hydrocortisone orally for five days. A more rapid subsidence of fever and relief of symptoms distinguished the hormone-treated group, although occasional recurrences followed withdrawal of hydrocortisone. No such recurrence or "rebound" of fever was observed on withdrawal of hormone in a con-

trolled blind trial by Kirby et al.[13] on 42 cases of pneumococcal pneumonia. All the patients received 2.0 g. of tetracycline daily, and half of them also received 32 mg. of methyl prednisolone on the first day, 16 mg. on the second and third days, and 8.0 mg. on the fourth day. Complications directly attributable to methyl prednisolone were not observed. Rapid defervescence in the steroid-treated group was the most noticeable feature of the study; at the end of 24 hours three quarters of the steroid-treated group were afebrile, compared with a third of the control group receiving tetracycline alone. At the end of 48 hours, nine tenths of those receiving steroids were afebrile, compared with only half the control group. Otherwise, there were no significant differences in the laboratory findings or in the resolution of the pneumonia; and complications were few and slight in both groups. Kirby et al. conclude that corticosteroids are not indicated in uncomplicated pneumonia, but that they may be of value in the highly febrile toxic patient. Aspirin has long held pride of place as a more acceptable alternative to the pctentially dangerous steroids in the symptomatic treatment of pneumonia; and a comparison of these two agents in conjunction with penicillin would be instructive. It seems likely that the antipyretic effect of steroids would be greater. This can be inferred from a controlled study by Petersdorf et al.[14] who compared aspirin and a placebo in 67 patients with pneumococcal pneumonia, all of whom were treated with penicillin. In the group which received aspirin, fever was not controlled more rapidly, and the only real difference in this group was greater symptomatic relief in the first 24 hours of treatment.

Initial clinical improvement is hastened by giving steroids with antibiotics in tuberculosis;[15] combined therapy, although not advisable as a routine, may be particularly useful when the patient is severely ill and toxic, when the pleura or meninges are involved,[16,17] or for controlling hypersensitivity reactions.[18] It remains to be seen whether steroids can conserve lung function and prevent long-term chronic respiratory disability.

In virus infections clinicians have been reluctant to give steroids, because no antibiotics are available as "insurance cover" and because of the reported hazards. Haggerty and Eley,[19] for instance, drew attention to 12 fatalities in children who were receiving corticosteroids at the time of exposure to chickenpox. None the less, corticosteroids have sometimes proved helpful in other virus infections such as infective hepatitis, infectious mononucleosis, mumps, and influenza. In case of virus hepatitis corticosteroids bring about a rapid fall in the serum-bilirubin level,[20] although serial aspiration liver biopsy studies have revealed no significant change in the underlying disease process.[21] Corticosteroid therapy is indicated for the fulminating condition bordering on hepatic coma, for hepatitis complicated by long-continued obstructive jaundice, and for relapses of the disease. Steroids are not indicated in ordinary uncomplicated hepatitis. In infectious mononucleosis corticosteroids are rarely indicated,[22] but they may be valuable when the disease is complicated by profound toxemia, severe hepatic involvement, or encephalomyelitis. Acute disseminated encephalomyelitis following measles, chickenpox, rubella, or vaccination against smallpox or rabies may be favorably influenced by steroid therapy, which diminishes the initial mesodermal inflammatory reaction but does not affect established axonal damage. The response of these acute neurologic disorders to cortisone supports the hypothesis that they are due to anaphylactic sensitization.[23,24]

When inflammatory exudate causes congestion in an unyielding space, the resulting pain and tenderness cause distress. By reducing inflammation, the corticosteroids can be expected to relieve discomfort. Such relief has been achieved both in mumps orchitis[25] and in neural leprosy.[26] As regards more

chronic conditions arising from virus infections Mickerson[27] has suggested that corticosteroid therapy may be beneficial in influenzal debility states.

The evaluation of these drugs in infections requires controlled trials. But much can be learned from the reports of observant clinicians called on to treat winter infections among patients receiving steroids for other reasons. In the antibiotic age the treatment of infections has so far been more effective than ever before. Will this advantage be maintained in the corticosteroid era?

References

1. Fischell, E. E., Stoerk, H. C., and Bjorneboe, M.: Proc. Soc. Exper. Biol., **77**:111, 1951.
2. Kilbourne, E. D.: J. Exper. Med., **101**:437, 1955.
3. Ebert, R. H., and Wissler, R. W.: J. Lab. & Clin. Med., **38**:497, 511, 1951.
4. Skanse, B., and Miörner, G.: Lancet, **1**:1121, 1959.
5. Jahn, J. P., et al.: J. Pediat., **44**:640, 1954.
6. Kinsell, L. W., and Jahn, M. P.: AMA Arch. Int. Med., **96**:418, 1955.
7. Lepper, M. H., and Spies, H. W.: Antibiotics Ann., New York, 1956-67, p. 447.
8. Magill, G. B., Killough, J. H., and Said, S. I.: Am. J. Med., **16**:810, 1954.
9. Woodward, T. E., et al.: Ann. Int. Med., **34**:10, 1951.
10. Smadel, J. E., Ley, H. L., and Diercks, F. H.: Ibid, p. 1.
11. Workman, J. B., et al.: New England J. Med., **246**: 962, 1952.
12. Wagner, H. N., Jr.: Bull. Johns Hopkins Hosp., **98**:197, 1956.
13. Kirby, J. C., Jr., Polis. G., and Romansky, M. J.: Am. J. M. Sc., **240**:30, 1960.
14. Petersdorf, R. G., et al.: Bull. Johns Hopkins Hosp., **101**:1, 1957.
15. Houghton, L. E.: Lancet, **1**:595, 1954; Tuberculosis Soc. Scotland, Brit. M. J., **2**:1131, 1957.
16. Turiaf, J., and Marland, P.: Bull. Soc. méd. Hôp. Paris, **29**:1174, 1955.
17. See Lancet: **1**:1135, 1959.
18. Houghton, L. E.: Ibid., **1**:595, 1954.
19. Haggerty, R. J., and Eley, R. C.: Pediatrics, 18:160, 1956.
20. Evans, A. S., Sprinz, H., and Nelson, R. S.: Ann. Int. Med., **38**:1134, 1953.
21. Shaldon, S., and Sherlock, S.: Brit. M. J., **2**:734, 1957.
22. Mason, R., and Adams, E. K.: Am. J. M. Sc., **236**:447, 1958.
23. Selling, B., and Meilman, E.: New England J. Med., **253**:275, 1955.
24. Miller, H. G., Stanton, J. B., and Gibbons, J. L.: Brit. M. J., **1**:668, 1957.
25. Petersdorf, R. G., and Bennett, I. L., Jr.: Arch. Int. Med., **99**:222, 1957.
26. Jopling, W. H., and Cochrane, R. G.: Leprosy Rev., **28**:5, 1957.
27. Mickerson, J. N.: Lancet, **1**:1118, 1959.

MEDICINE AND THE LAW

Following is an excerpt from "Medicine and the Law: Opinions of the Judicial Council" (J.A.M.A., 174:81 Sept. 3, 1960), in which readers of THE JOURNAL may be interested:

Question. May a member of the American Medical Association ethically employ an optometrist as an assistant?

Answer. It is unethical for a doctor to hire an optometrist as an assistant if the optometrist is held out to the public or to the doctor's patient as a doctor of optometry or as a licensed optometrist. It is not unethical, however, for a doctor of medicine to hire one who may have been trained or who may have a degree in optometry if the individual so hired is not held out or does not hold himself out to the public as an optometrist. In accordance with the policy of the House of Delegates classifying optometrists as irregular practitioners, the Council has expressed the opinion that, whereas a doctor of medicine may utilize the services of one trained or licensed in optometry, he may not by his association with the optometrist raise the practice of optometry to the same high plane as medical practice.

CORRESPONDENCE

THE ORINDA VISION STUDY

Editor,
American Journal of Ophthalmology:

The Orinda Vision Study has been discussed widely and has been interpreted in many diverse ways. Because several groups were represented in the formulation of this

study and the opinions were frequently widely divergent, the conclusions of the study do not reflect our personal opinions. We should like to state our personal opinion of routine school eye examinations, which is as follows:

Routine school eye examinations fail to discover most serious ocular conditions until it is too late. As examples: the infant with congenital glaucoma would be blind unless treated by the time he is of school age; the infant with retinoblastoma would be dead; the strabismic child is deeply amblyopic by then and except for obvious cosmetic repair little can be done.

It is improbable that the detection of simple refractive errors often makes a real practical difference to the child. The usual myope does well in school and by the time he has to move to the blackboard in order to see it, the detection of myopia does not require examination. At the time of our meetings during this study, it was suggested that we determine whether there was any correlation between a school child's asthenopia and performance of his school work, personality problems and the like. It was our understanding that the Orinda Study would not be published until the children who had been given glasses were checked in regard to their school performance, personality, attitude, and so forth, and checked against a control group which had a comparable degree of refractive error and were not given glasses. This study was to go on for approximately five years, and it was very strongly stated that it would be the only method in determining whether or not referrals were indicated. For various reasons we were told that the study could not encompass this.

In light of the fact the routine school examinations do not detect the more serious difficulties until they are too late and that the simple refractive errors are of questionable importance, it is believed that the question of school examinations has assumed an importance far greater than it deserves. It is suspected that this study has been used by some groups to further their personal gains.

(Signed) Jerome W. Bettman, M.D.
Victor G. Fellows, M.D.
San Francisco, California.

Efficiency of Ishihara test

Editor,
American Journal of Ophthalmology:

The May, 1960, issue of The Journal contains an article by Dr. Akira Nakajima and four other Japanese physicians which concerns the diagnostic efficiency of a recent edition of the Ishihara test. Dr. Nakajima and his co-authors state that "so far no one has attempted to investigate the theoretical background which would enable an examiner to plan and predict the efficiency of the screening by any set of pseudo-isochromatic plates." I would like to call their attention to three previously published papers which are apparently not known to them.

1. Two criteria for the selection of color vision test plates. Earl L. Green and Louise L. Sloan, J. Optical Soc. Am., **35**:723-730, 1945.

2. An improved screening test for red-green color deficiency composed of available pseudo-isochromatic plates. Louise L. Sloan, J. Opt. Soc. Am., **35**:761-766, 1945.

3. Tests for color deficiency based on the pseudoisochromatic principle: A comparative study of several new tests. Louise L. Sloan and Adelaide Habel, AMA Arch. Ophth., **55**:229-239, 1956.

The 1945 paper by Green and Sloan developed a statistical procedure for rating each pseudo-isochromatic plate in accordance with its diagnostic efficiency. It also showed how one may predict from the individual ratings the screening efficiency of any given selection of plates. In the second paper published in 1945, the procedures developed by Green and Sloan were used to select a set of 18

plates having high diagnostic efficiency from those available at that time.

The 1956 paper by Sloan and Habel is of particular interest for comparison with the studies of Nakajima, et al., because it includes data on an earlier 14-plate version of the Ishihara test which are in surprisingly close agreement with the results of the more recent Japanese investigation. On the 14-plate Ishihara test we found, for example, that 96 percent of normals made two or less errors, 100 percent, three or less. Nakajima, et al., using a 16-plate test, similarly found that 96 percent of the normal group made two or less errors, 99.5 percent, three or less. In our study 93 percent of color-deficient subjects made eight or more errors, in the Japanese study 98.6 percent (80 of 81) of this group made nine or more errors. The small group (3.1 percent) of definitely color-deficient subjects who, in our study, made three or less errors would have been classed as normal in the Japanese study because no confirmatory tests were given to those making less than four errors.

The measures of diagnostic efficiency of the individual plates (called "rates of misclassification" in our study, "probabilities of misreading" in theirs) are likewise similar. In our study the percent of normals failing varied from 0 to 26 percent for the different plates with a mean of 4.1 percent. In the study by Nakajima, et al., the percentages varied from 0.1 percent to 19.3 percent with a mean of 3.4 percent. In the color-deficient group the percent passing each plate in our study varied from 1.0 percent to 31.6 percent with a mean of 11.8 percent. The corresponding figures reported in the Japanese study are 0.0 percent and 39.5 percent with a mean of 7.1 percent. The more recent edition of the Ishihara test appears to be the better of the two but both versions include a few relatively unsatisfactory plates.

(Signed) Louise L. Sloan, Ph.D.,
Baltimore, Maryland.

* * * *

DR. NAKAJIMA'S REPLY

Editor,

American Journal of Ophthalmology:

We are very sorry to have overlooked the valuable papers of Sloan, et al., who very kindly pointed out the existence of their works and compared their results with ours. We did not make a thorough investigation of the literature, and no reference had been made by Belcher, et al., or Kettesy about the work of Sloan and her collaborators. Although this manuscript was sent to Dr. D. Farnsworth before publication, the omission to Sloan's work was not discovered.

We think that the probability of misreading is simpler in definition, more clear cut and more useful than the misclassification rate of Sloan, et al. In addition, no reference is made in their paper to the type of distribution of misreadings. We approximated this by Poisson distribution as a first approximation, and it fitted fairly well with the observed distribution. It was practically impossible to do an anomaloscopic examination on as many as 3,000 school children but the probability of misreadings and the theoretical prediction by use of the observed data tell us that the probability for color vision defectives in groups with misreadings is less than four, practically negligible. In fact, we did a sample survey by the anomaloscopic test in the group misreading four (20 percent) and all examined proved to be normal. For these two reasons, we may say that the probability of misclassification in our series is very small.

Dr. Sloan points out in her letter that the new edition of the Ishihara test is better, comparing the rate of misreading in our series and in her series. In addition, the subjects in our series were school children aged between six and 10 years, and in Sloan's series the children were over eight years of age. Our results show that misreading decreases with age. Considering this point, the newer edition of the Ishihara test

seems even better than the former edition. We think that this kind of work should be carried out before a newer edition is issued, the result being contained in the illustration. This will be very useful to the users of the tests.

(Signed) Akira Nakajima, M.D.,
Tokyo, Japan.

BOOK REVIEWS

THE PRINCIPLES AND PRACTICE OF REFRACTION. By G. H. Giles, O.B.E.F.B.O.A., F.S.M.C., D.Orth. Philadelphia and New York, Chilton Company, 1960. 678 pages and index. Price: $17.50.

This book, written by a British ophthalmic optician (optometrist) for optometrists, deals competently and exhaustively with the practical aspects of refraction as practiced by the nonmedical refractionist. Omitted are any chapters on basic physiologic optics but included are many chapters which one is surprised to find in a book of this sort. Some 67 pages are devoted to perimetry and scotometry, based mainly on Traquair's classical concepts. Orthoptics receives major consideration, as might be expected in view of the author's special interest in this subject. Special chapters are devoted to the use of drugs, special instruments (including the slitlamp), contact lenses, aniseikonia, and the principles of dispensing.

One is impressed by the fact that legal aspects and responsibilities must separate the British ophthalmic optician from his American optometric counterpart. This is particularly apparent from the discussion as to the use of drugs recommended for use by the nonmedical refractionist, including cycloplegics, local anesthetics, antiseptics, and staining agents. Close co-operation with the medical profession is recommended and patients are to be referred in cases of definite or suspected pathology; however, the discussion of slitlamp microscopy, gonioscopy, and tonometry seems far beyond the scope of the sight-testing optician.

The inclusion of such subjects as pleoptics and the latest designs in contact lenses indicates that this book is quite up-to-date in its approach and the author has a facility of expression which makes the work pleasurable reading. With little appeal to the ophthalmologist this new treatise on practical refraction should be a valuable reference work for the optometrist.

William A. Mann.

MEDICAL AND BIOLOGICAL RESEARCH IN ISRAEL. Edited by M. Prywes, M.D. New York, Grune & Stratton, 1960. 563 pages plus xix, 46 illustrations and 4-page pull out panorama of Hebrew University, 2-page map of Israel. Price: $8.00.

The founders of Israel realized that only through arduous scientific endeavor could the nation survive from its meager natural resources. Fortunately for this unique approach, Israel is the most cosmopolitan and the most intellectual of the fledgling nations. Nine tenths of its numerous physicians (1:400 of the general population) previously practised in their country of origin. This survey summarizes the principal investigations in medicine and biology carried out since the State of Israel was established in 1948. The bibliographic index lists over 2,000 references. One part of this compilation deals with applied research in public health, agriculture and stock-raising; the other part describes fundamental investigations in the various fields of medicine and biology. Epidemiologic problems of trachoma and schistosomiasis have been successfully handled. The numerous publications of the Department of Ophthalmology have appeared in English in the ophthalmic and scientific journals of America and England. Prof. Michaelson's monograph, "Retinal circulation in man and animals," explained the vascular changes in various types of retinopathy including the retinopathy of prematurity. In vernal catarrh, a specific diagnostic test was evolved by Neumann and Bulmen-

krantz—0.1-percent toluidine blue applied to the mucopolysaccharide secretion results in an abundant precipitate colored violet. Investigation of the trachoma virus demonstrated a close antigenic relationship between the Chinese and Israel strains. Auerbach, previously associated with Wald, continued in Israel his studies on the mechanism of vision. Research in the history of medicine has been facilitated by the Harry Friedenwald Library. This celebrated ophthalmologist was a zealous student of medical history, wrote the scholarly "Jewish Luminaries in Medical History," and bequeathed his library to the Hebrew University, which contains many rare items including the 1543 and 1555 editions of Vesalius, the Canon of Avicenna (1491) and the works of Malpighi, Morgagni and Maimonides.

One must have a dream for a dream to come true. The people of Israel may feel with some content, in the fulfilment and promise revealed in this book, that the present is the future that they dreamed of in the past.

James E. Lebensohn.

HUMAN PITUITARY HORMONES. Edited by G. E. W. Wolstenholme and M. O'Connor. Ciba Foundation Colloquium. Boston, Little, Brown and Company, 1960. 336 pages, 86 illustrations, index. Price: $9.50.

This colloquium on human pituitary hormones was held in Buenos Aires in August, 1959, to honor that great Argentinian physiologist, Bernardo Houssay. The intimate anatomic and physiologic relationship of the pituitary to the eye makes this volume of interest to ophthalmologists. The various pituitary hormones are considered, including thyroid-stimulating hormone (TSH). An apparently reliable method for the determination of TSH is described by Bottari and values are given for the euthyroid, hypothyroid and hyperthyroid patient. Although there is some correlation between TSH values in the blood and thyroid state, there is no such correlation with exophthalmos. This leaves "pituitary exophthalmos" as a syndrome rather than as a verified disease entity.

It is amusing to note that endocrinologists are as prone as bureaucrats to the multiplication of alphabetical abbreviations. In the pituitary they list the following agencies: GSH, FSH, LTH, TSH, ACTH and ICSH (or is this LH?). These terms, incidentally, do not come from the NIH of the USPHS but they are certainly part of H E and W.

David Shoch.

LECTURE NOTES ON OPHTHALMOLOGY. By Patrick D. Trevor-Roper. Springfield, Illinois, Charles C Thomas, 1960. 94 pages, 76 illustrations, index. Price: $3.50.

Mr. Trevor-Roper has the admirable ability of saying a great deal in few words. As a result, there is more packed into the 94 pages of this book than usually is found in volumes many times its size. His approach to the review of ophthalmology is organized as to presenting complaints—the painful, red eye; the injured eye; sudden and gradual loss of sight in quiet eyes—and so forth. Although *Lecture Notes on Ophthalmology* is written primarily as a guide for students and general practitioners, ophthalmologists will find it enjoyable and worthwhile reading.

Thomas H. F. Chalkley.

OEIL ET VIRUS. By Roger Nataf, Pierre Lépine and Georges Bonamour. Paris, France, Masson and Company, 1960.

This magnificent 1000-page monograph provides a thorough and extensive exposition of the ocular manifestations of the virus diseases of the human body. Each segment is provided with an extensive bibliography. There are 172 figures in the text and 20 excellent plates, 17 of which are in color.

F. H. Haessler.

ABSTRACT DEPARTMENT

EDITED BY DR. F. HERBERT HAESSLER

Abstracts are classified under the divisions listed below. It must be remembered that any given paper may belong to several divisions of ophthalmology, although here it is mentioned only in one. Not all of the headings will necessarily be found in any one issue of the Journal.

CLASSIFICATION

1. Anatomy, embryology, and comparative ophthalmology
2. General pathology, bacteriology, immunology
3. Vegetative physiology, biochemistry, pharmacology, toxicology
4. Physiologic optics, refraction, color vision
5. Diagnosis and therapy
6. Ocular motility
7. Conjunctiva, cornea, sclera
8. Uvea, sympathetic disease, aqueous
9. Glaucoma and ocular tension
10. Crystalline lens
11. Retina and vitreous
12. Optic nerve and chiasm
13. Neuro-ophthalmology
14. Eyeball, orbit, sinuses
15. Eyelids, lacrimal apparatus
16. Tumors
17. Injuries
18. Systemic disease and parasites
19. Congenital deformities, heredity
20. Hygiene, sociology, education, and history

1

ANATOMY, EMBRYOLOGY, AND COMPARATIVE OPHTHALMOLOGY

Rohen, J. and Voth, D. **The iris structure of primates.** Ophthalmologica **140**: 27-33, July, 1960.

The majority of authors have felt that the iris crypts and other evidences of stromal tissue reduction, so characteristic of the human species, did not extend further back in the class Primates than to the gorilla. By studying many species of half-monkeys and Simians, the authors conclude that such is not the case, and that these changes are wide-spread throughout the entire class.

Lawrence T. Post.

Speakman, J. S. **Drainage channels in the trabecular wall of Schlemm's canal.** Brit. J. Ophth. **44**:513-523, Sept., 1960.

Numerous minute and gross grooves have been described in the trabecular wall of Schlemm's canal but since all of them had been observed in post-mortem specimens, they may have been artifacts. Speakman studied this same area in both human and monkey eyes, using a rapid fixation to avoid the occurrence of post-mortem artifacts. The observations were made with paraffin and India ink injections and plasticene preparations were made in some of the preparations. It was borne out that there is network of minute canals in the endothelial lining of the canal; these have openings of up to 6 μ in diameter and these are the exit openings of spiralling channels 5 to 10 μ in length which communicate with the underlying trabecular meshwork. They represent the final pathway of the aqueous in reaching the lumen of the canal. The author suggests that this area be named the endothelial meshwork. (12 figures, 7 references) Morris Kaplan.

2

GENERAL PATHOLOGY, BACTERIOLOGY, IMMUNOLOGY

Iverson, H. A., Hursh, M.D. and Lewis, A. **Toxoplasmosis.** Brit. J. Ophth. **44**:537-540, Sept., 1960.

A group of patients in northern Nigeria was examined fundoscopically and of these 17 were found to have evidence of chorio-retinitis. In four the lesions were inactive while in 13 they were found to be active. From all of them blood samples were drawn for toxoplasmosis studies and of the 17 patients 15 had positive titers

of 1:16 or over which is a ratio of 88 percent positive. (6 references)

Morris Kaplan.

3

VEGETATIVE PHYSIOLOGY, BIOCHEMISTRY, PHARMACOLOGY, TOXICOLOGY

Davis, J. R. and Shackel, B. **Changes in the electro-oculogram potential level.** Brit. J. Ophth. **44**:606-618, Oct., 1960.

The eyeball may be conceived of as a battery with a positive pole in the cornea and a negative pole in the retina. The corneo-retinal standing potential is the actual potential difference measured between the two structures. Changes in the position of the eyeball cause changes in the potential at the skin surface about the eye socket. (E.O.G.). The mean potentials are fairly constant for each subject. A day-to-day fluctuation may be as large as 50 percent of the mean. The older the subject, the greater were the changes in the E.O.G. levels found. A relation to atmospheric conditions is indicated by the daily variations which were found. (7 figures, 23 references) Irwin E. Gaynon.

De Vincentiis, M. **Further quantitative spectrophotometrical observations on the fluorescence of fluids in the eye.** Ophthalmologica **140**:115-120, Aug., 1960.

This article presents an amplification of data published by the same author in 1957. Rabbit aqueous and human subretinal fluid (from a patient with a one-month-old detachment) are examined by means of a spectrophotometer. The spectral energy distribution patterns of these fluids are depicted graphically. The observations suggest the presence in intraocular fluids of substances containing pteridine nuclei, a fact which, interestingly, was already indicated by entirely different methods of investigation. The similarity of rabbit to human aqueous is emphasized. As far as subretinal fluid is concerned, the author finds it much more like aqueous than like blood serum and believes that subretinal fluid is largely derived from intraocular fluids and not from transudation from blood vessels. (3 figures, 9 references)

Lawrence T. Post.

Geeraets, W. J., Williams R. C., Chan Guy, Ham, W. T., Jr., Guerry, Dupont, III and Schmidt, F. H. **The loss of light energy in retina and choroid.** A.M.A. Arch. Ophth. **64**:606-615, Oct., 1960.

The fundus of enucleated eyes of rabbit and man absorbs radiant energy primarily in the spectral range between 400 and 100 mμ. The rabbit is an excellent test animal for the investigation of thermal hazards to the retina since its light absorption is very similar to that of man. (11 figures, 2 tables, 10 references)

Edward U. Murphy.

Hagmüller, K. and Trichtel, F. **Autoradiographic studies on the penetration of iodine into the ocular tissues in iontophoresis.** Ophthalmologica **140**:44-54, July, 1960.

Ten years ago Von Sallman and Dillon reported the first of these studies (A.J.O. 33:429-34, 1950), which concern themselves with the demonstration of radiolabelled iodide ions transported to various ocular tissues by the aid of iontophoresis. The present study offers refinements in technique. Neither the original nor the present authors are immediately concerned with any clinical application of their observations. (6 figures, 23 references) Lawrence T. Post.

Hanna, C. and O'Brien, J. E. **Cell production and migration in the epithelial layer of the cornea.** A.M.A. Arch. Ophth. **64**:536-539, Oct., 1960.

Tritium-labeled thymidine was injected into the anterior chamber of experimental animals and the movement of corneal epithelial cells studied by means of autora-

diographs after enucleation at various intervals. (1 figure, 5 references)

Edward U. Murphy.

Hockwin, O. and Weigelin, E. **A method for determining the concentration of butazolidin in the human aqueous after peroral administration.** Arch. f. Ophth. **162**:133-136, 1960.

The authors' study shows that is is probable that the concentration is increased with intraocular inflammation and possibly the age of the subjects influences the butazolidin-concentration-gradient between plasma and aqueous. (2 figures, 1 table, 9 references)

F. H. Haessler.

Hofmann, H. and Lembeck, F. **Experimental study of the mechanism of action of zonulytic ferments.** Arch. f. Ophth. **162**:111-119, 1960.

The authors made microscopic studies of the tearing of zonula fibers as a result of increased tension and also with the addition of enzymes. They confirmed previous observations that enzymatic zonulolysis can only take place in fibers under tension. The fibers differ from other ocular tissues in that they undergo almost no enzymatic change through trypsin or alphachymotrypsin. As an explanation for the limitation of activity of the enzymes to zonula fibers under tension the authors assume that intramolecular structural changes occur in the proteins of the fibers. (3 figures, 14 references)

F. H. Haessler.

Jackson, G. G. **Proper use of antibiotics.** Tr. Am. Acad. Ophth. **64**:694-699, Sept.-Oct., 1960.

In this general discussion anatimicrobial agents are divided into four groups: heterocyclic compounds, polypeptides, antifungal agents, and chemotheropeutic agents. (1 table) Harry Horwich.

Laffers, Z. and Bozsóky, S. **The significance of C-reactive protein determinations in inflammatory conditions of the eye.** Ophthalmologica **140**:104-114, Aug., 1960.

The authors find no correlation between serum C-reactive protein levels and inflammations of the eye. Although C-reactive protein was discovered in the eyes of 11 out of 32 patients with uveitis, its appearance did not seem to be related to the etiology or type of inflammatory condition. (7 tables, 21 references)

Lawrence T. Post.

Laue, H. **The latent period (retino-thalamo-cortical) in the rabbit of stimulation with equal-energy varicolored light.** Arch. f. Ophth. **162**:205-214, 1960.

Stimulation of rabbits' eyes with lights of equal energy and from various spectral regions showed that it was only with red light (λ max 641μ) that no electroretinogram and no specific action potentials of the lateral geniculate body and the cortex could be derived. Similar latent periods of the eye and brain action potentials were found in spectral regions of shorter wave length—blue, green, and yellow. The fact that individual stimuli of equal energy in a spectral region greater than 600 mμ do not give rise to action potentials suggest that red light gives rise to a visual impression in the rabbit. (7 figures, 20 references) F. H. Haessler.

Lembeck, F. and Hofmann, H. **Experiments in inhibition of enzymatic zonulolysis.** Arch. f. Ophth. **162**:120-123, 1960.

When using enzymatic zonulolysis in cataract extraction the enzyme solution usually disappears from the anterior chamber during the surgical procedure. However, when high concentrations are used it is occasionally desirable to use an experimentally tested inactivator. The authors found that in the ox eye KalliKrein-

inactivator slightly inhibits the zonulolytic action of trypsin and that the Soya bean inhibitor does so greatly. The latter can be injected into the anterior chamber of the eye of the rabbit without causing any irritation where the KalliKrein-inactivator is injurious. If the soybean inhibitor is injected into the anterior chamber of the rabbit eye one minute after the injection of a quantity of trypsin or alpha-chymotrypsin, enzyme injuries can be prevented.

These experiments provide data which can be useful in the management of zonulolysis in the human eye. (1 table, 3 references) F. H. Haessler.

Macri, F. J. **Further studies on the action of acetazolamide and the venous pressure of the eye.** A.M.A. Arch. Ophth. **64**:550-552, Oct., 1960.

From studies on anesthetized cats, when intraocular pressure is maintained it appears that the fall in venous pressure is not a secondary effect. The simultaneous fall in eye pressure may be mediated in part by this drug's effect on the venous pressure. (2 figures, 2 references)

Edward U. Murphy.

Müller, H. K., Hockwin, O. and Kleifeld, O. **The determination of pilocarpine in the human aqueous by polarography.** Arch. f. Ophth. **162**:107-110, 1960.

The authors have recently shown that the ability of the lens to absorb oxygen from a nutrient solution can be reduced or completely inhibited by the addition of pilocarpine. They now describe a method for determining the pilocarpine content of the aqueous by means of polarographic adsorption-analysis. (3 figures, 1 table, 4 references) F. H. Haessler.

Witmer, R. and Bühler, E. **Immune electrophoresis of the lens.** Arch. f. Ophth. **162**:193-204, 1960.

The authors show that the human lens has at least three or four proteins in common with the lens of mammalian eyes but that on the other hand it has one protein fraction belonging to a crystallin which is specific only for man. (5 figures, 31 references) F. H. Haessler.

Zagora, E. **A study on the biochemical and biophysical behavior of the trabeculum.** Ophthalmologica **140**:120-128, Aug., 1960.

On the assumption that alterations in the "delicately balanced hydration of the inner connective tissue core" of the trabecular fibers should lead to changes in fiber thickness and thus to alterations in facility of aqueous outflow, the writer reports the results of bathing bovine trabeculae in various solutions. The experimental method is only vaguely suggested, and no results are tabulated. Apparently, fresh trabeculae were "teased" from enucleated eyes, examined unstained by phase-contrast microscopy, then immersed in the test liquid and "weighed at regular intervals" with "an analytic balance." No further details are given. A table states whether the solutions caused swelling or shrinking. There follows a long and involved discussion (complicated by the author's difficulties with the English language, he is from Lodz, Poland) in which the author theorizes as to how alterations in aqueous composition might similarly alter the trabecular interstices. In view of the various pore-size experiments previously reported, and especially the recent work of Ake Holmberg it would seem probable that the space between trabecular fibers has little to do with outflow resistance; therefore, considerable doubt might be cast on the thoughts adumbrated in this paper. (1 figure, 1 table, 3 references)

Lawrence T. Post.

4

PHYSIOLOGIC OPTICS, REFRACTION, COLOR VISION

Chamlin, Max. **Fluctuations in size of the normal blind spot.** A.M.A. Arch. Ophth. **64**:522-527, Oct., 1960.

Forty-five normal subjects were examined five or six times at one and two meters. Clinically it can be stated that fluctuations in either width or height are suspicious of abnormality if over one third of one degree, and particularly if over one half of one degree. (2 tables, 7 references) Edward U. Murphy.

Willetts, G. S. **A survey of patients using spectacle magnifiers.** Brit. J. Ophth. **44**:547-550, Sept., 1960.

Forty-four patients who had been fitted with Igard Hyperocular Spectacle Magnifiers over a period of 18 months were reexamined for an evaluation of results. Of these patients 57 percent had found the lenses satisfactory, 17 percent found them to be of limited use, and 26 percent had found them useless. It was concluded that these lenses are much more useful for the younger patients than the elderly. (2 references) Morris Kaplan.

Wolf, Ernst. **Glare and age.** A.M.A. Arch. Ophth. **64**:502-514, Oct., 1960.

Scotomatic glare conditions were studied in 112 individuals between the ages of five and 85 years. Ability to distinguish the targets grew progressively less with increasing years. A 50 to 70-fold difference was noted between the extremes of age and at age 40 a sudden acceleration in sensitivity to glare occurs. It is suggested that lens changes are responsible. (9 figures, 30 references)

Edward U. Murphy.

5

DIAGNOSIS AND THERAPY

Culling, C. F. A., Martin, W. R. J. and Smith, E. L. **The preparation of sections and museum specimens of eyes using a polyester resin.** A.M.A. Arch. Ophth. **64**: 558-565, Oct., 1960.

The plastic used is known as C.M.E. tissue support resin and may be handled like celloidin. However it may be cut thinner and can be finished in four or five days. The block from which the sections are cut may be used afterwards as a museum specimen. (3 figures, 5 references)

Edward U. Murphy.

François, J. and Rouck, A. **Electroretinography in the diagnosis of blindness in the newborn.** Ophthalmologica **140**:1-13, July, 1960.

The importance of electroretinography as a diagnostic and prognostic aid remains clouded, despite considerable enthusiasm in the literature. This paper attempts to show its usefulness in yet another category of cases. The authors present examples of ERG findings in four groups of patients, but they are particularly interested in distinguishing cases of hereditary, congenital, chorioretinal (tapeto-retinal) atrophy of Leber. This is a disease characterized by poor vision from birth, which progressively becomes worse with the passage of years. At first there may be no obvious retinal abnormalities, but later signs of typical retinal degeneration occur. The ERG is absent from the start. The fundus picture can resemble that of retinopathies caused by intra-uterine infections, but in these cases the ERG is normal. An early differential diagnosis is thus possible. A summary of ERG findings concludes the paper. Most of them are predictable, if one recalls that the ERG is obliterated or reduced in affections of the retina itself, and is normal in disease of the ganglion cells and optic pathways.

The authors find the ERG particularly interesting in cases of congenital cataract, since it gives an idea of the functional state of the retina. However, they add

that 1. there is no relationship between the amplitude of the ERG and the visual acuity level, 2. a normal ERG does not guarantee a satisfactory functional result, and 3. a subnormal ERG is not sufficient reason for rejecting surgery. However, the ERG is interesting. (6 figures, 2 tables, 11 references)

Lawrence T. Post.

Friedman, A. P. and Carton, C. A. **Facial pain.** Tr. Am. Acad. Ophth. **64**:713-719, Sept.-Oct., 1960.

The authors divide facial pain into three groups: 1. typical neuralgias, primarily neurogenic; 2. atypical neuralgias, primarily vascular and psychogenic; and 3. facial pain secondary to other extracranial and intercranial causes. The two types of neuralgia are tabulated. Typical cases are characterized by short sharp paroxysms with freedom between attacks, and are treated by Dilantin or surgical block. The atyptical ones include histomine cephalagia, cluster headaches, and many others. They are not well localized, may be paroxysmal or continuous, and are often associated with autonomic disturbances. This group seems to be due to dilatations in branches of the external carotid artery. Treatment here is through psychotherapy, ergotamine, caffeine, and sedatives. The various intracranial and extracranial causes of secondary facial pain are merely listed. (4 references)

Harry Horwich.

Grósz, I. **Clinical experience with hydrocortison eye salve.** Szemeszet **97**:162-167, 1960.

The first Hungarian hydrocortison eye salve of standard composition proved good in superficial ailments of the eye of allergic character. Although hydrocortison is not a specific drug it decreases hyperemia, pain, and edema. All complications of general hormone therapy may be eliminated in this way. In cases giving no response to ointment, two or three times a day, subconjunctival injection can be attempted. Peroral or parenteral, that is, systemic administration, is only seldom used, exclusively in severe, posterior processes such as chorioretinitis centralis or sympathetic ophthalmia. Contraindications are superficial herpes and ulcus serpens, and its use after new perforating injuries or operations is also not recommended because of possible derangement of the healing process. In case of correct indications there are almost no harmful side effects. The suitable basic material and sterility warrant a wide spectrum of use. Absolute indications are palpebral, retinal and cornea processes, adenoviral infections, viral keratitis, keratitis parenchymatosa, keratitis disciformis, subconjunctivitis, and ectodermosis pluriorificialis. Relative indications are rosacea conjunctivae et corneae, episcleritis, conjunctivitis vernalis, keratitis lymphatica, iritis acuta, iritis hypertensiva, the second stage of postoperative treatment. Its use gave no results in keratoid degenerations, in Sjögren's syndrome, and in posterior processes. Suspicion of tuberculosis makes cautiousness advisable.

Gyula Lugossy.

Krwawicz, Tadeusz. **Intra-corneal lamellar keratoplasty.** Brit. J. Ophth. **44**: 629-633, Oct., 1960.

A 4 mm. incision is made at the limbus with a keratome. The cornea is then split longitudinally, first with a cystotome and then with a small flat knife. A pocket is formed whereby a 5 mm. lamellar graft is introduced. The graft is made smooth and lies within the pocket. The graft is held in place by the scarred cornea. No sutures are used. Six to eight days later a 4 mm. trephine is used to remove the scarred overlying cornea. Six cases are reported. (10 figures, 1 table, 2 references)

Irwin E. Gaynon.

Michaelson, I. C. **Transcleral division of mid-vitreous membrane under visual control.** Brit. J. Ophth. **44**:634-635, Oct., 1960.

A report is given of a patient in whom a return of vision to 6/15 occurred in an eye blinded for seven years. An intracapsular cataract extraction was done. This was followed by four vitreous aspirations. Using the slitlamp beam as guide, a transcleral division of a mid vitreous membrane was done. (1 figure)

Irwin E. Gaynon.

Papper, E. M. **The proper use of tranquilizers in surgical patients.** Tr. Am. Acad. Ophth. **64**:689-693, Sept.-Oct., 1960.

The phenothiazine derivatives produce the most useful effects for surgical premedication. Of this group perphenazine produces the least side effects. It potentiates other commonly used premedicants, enhances their drying effects, and improves postoperative sedation with smaller doses of narcotics. They also decrease nausea, emesis and delirium on emergence from anesthesia.

One must be wary of complications from spinal and epidural anesthesia, and even of general anesthesia when there is inadequate blood volume or circulatory function. (2 tables, 10 references)

Harry Horwich.

Queiroga, G. **Slitlamp photography.** Ophthalmologica **140**:129-134, Aug., 1960.

A photographic attachment for Haag-Streit (and presumably other, adaptable) slitlamps is presented. The chief difficulties with slitlamp photography have related to improper illumination and the fact that the slit beam is in focus in only one plane at a time. To overcome these difficulties, two sources of illumination are supplied, one diffuse, the other the ordinary slit beam, whose depth of focus is greatly increased by using a much smaller diaphragm opening and a light of correspondingly greater intensity to compensate for it. If the black and white reproductions of color transparencies presented in this article are an indication of the average result, the author has indeed made a significant contribution. (4 figures, 6 references)

Lawrence T. Post.

Setti, R. I. **The use of strontium-90 in ophthalmology.** Arq. brasil. de oftal. **23**: 91-103, 1960.

Beta radiation, as a disintegration of radium, has been used therapeutically for over fifty years. In recent years the development of nuclear reactors has resulted in the production of radioactive substances which may be used as a substitute for radium. The author reviews briefly the physics of radioactivity and shows that Strontium-90 as a source of Beta radiation has a half life of adequate duration, produces Beta particles which penetrate tissues sufficiently, produces no Gamma rays and can be produced in a chemically pure state with a high degree of specific activity.

Its half life is 28 years. The penetrating Beta particles are produced by the disintegration of the Strontium-90 into Yttrium-90, which in turn decomposes into stable Zirconium. In the applicator both radioactive elements are in a state of equilibrium. The applicator used by the author has an active area of 0.7 square centimeters. The depth of penetration within the tissues is 8 mm. although the maximal therapeutic effect seldom exceeds 4 mm. The effective percentage of the dose applied varies from 100 percent on the surface to only 6 percent at a depth of 4 mm. There is a variable patient sensitivity to the radiation, and a preliminary cutaneous test is recommended.

Application of Beta radiation with the Strontium-90 applicator is easy and painless and can be readily used in treating children and the elderly. A brief review of ocular diseases amenable to Beta radia-

tion, such as papillomata, angioma, basal carcinoma, corneal vascularity, pterygium, corneal ulcers, and some types of keratitis, is presented. (23 references)

James W. Brennan.

6

OCULAR MOTILITY

Davidson, Sidney I. **Abiotrophic ophthalmoplegia externa.** Brit. J. Ophth. **44**: 590-599, Oct., 1960.

A case of external ophthalmoplegia associated with a typical retinitis pigmentosa is reported. The heredo-degenerative familial diseases are all different manifestations of a single basic defect. The lesions may be single or multiple. The manifestations are dependent upon the site of pathologic change. The literature is reviewed. (7 figures, 55 references)

Irwin E. Gaynon.

Girard, L. J. and Beltranena, F. **Early and late complications of extensive muscle surgery.** A.M.A. Arch. Ophth. **64**:576-584, Oct., 1960.

Detachment of three or four rectus muscles of one eye may lead to serious complications in adults, apparently by interfering with the anterior ciliary circulation. Six cases are reported showing such sequelae as iridocyclitis, necrosis of the iris, cataract, and sloughing of the anterior portion of the sclera. There were no such complications following surgery on all four rectus muscles of 11 children. (11 figures, 8 references) Edward U. Murphy.

Lian, Oey-Khoen. **Muscle transplantation after a complete severance of the medial rectus muscle.** Brit. J. Ophth. **44**:637, Oct., 1960.

The medial portion of the superior and inferior rectus muscles was transplanted to the stump of a traumatically severed medial rectus muscle. Two hours after surgery adduction was present. No head tilt or diplopia occurred, except on looking to the extreme left. (11 figures, 5 references) Irwin E. Gaynon.

Matteucci, Pellegrino. **Strabismic amblyopia.** Brit. J. Ophth. **44**:577-582, Oct., 1960.

A satisfactory definition of strabismic amblyopia has not been made. The amblyopic eye in concomitant squint has a decrease in the visual acuity, perception of shape, deficiency of fixation, difficulty of separation, and a lack of motor coordination.

Fixation deficiency is important. Improvement in visual acuity by pleoptic therapy depends upon the attainment of central fixation. Early and prolonged treatment is required to correct the separation deficiency. Only then is there a chance that the visual acuity will improve. (4 figures, 21 references) Irwin E. Gaynon.

Matteucci, P. and Pasino, L. **Monocular unsteady and eccentric fixation in squint amblyopia.** Opthalmologica **140**:81-87, Aug., 1960.

The authors first cite the varied classifications which have been suggested for suppression amblyopia, and emphasize the confusion in the literature. Particular concern is expressed over the relatively simple classification of Cüppers and Bangerter, in which all ambloypia is divided into two major groups, those with and those without eccentric fixation. With allusions to clinical data which are not presented, the authors suggest that all suppression amblyopia is associated with unsteadiness of fixation more or less apparent, and that less frequently there is a relatively constant eccetricity of fixation. They suggest this to be a simpler and more useful concept than the more complicated schemes offered by other investigators in the field. (1 figure, 15 references)

Lawrence T. Post.

de Muelenaere, H. **Interpretation of schemes of ocular motility.** Ann. d'ocul. **193**:860-880, Oct., 1960.

A review of the actions of each of the extraocular muscles is given. These are graphed schematically. The author prefers the use of the Hess chart to analyze clinical paresis. He illustrates the typical chart in hypothetical cases of paresis of each of the extraocular muscles and then gives a few clinical examples. (14 figures)
David Shoch.

Piper, H. F. and Holland G. **Clinical and electrographic viewpoints in the evaluation of ocular paralysis and nystagmus.** Arch. f. Ophth. **162**:137-165, 1960.

This discussion is based on detailed studies of 23 patients, each of which is summarized extensively. The authors assume that one finds a hyperkinetic nystagmic and a hypokinetic-paretic factor in every disturbance gaze. The electro-oculographic method makes it possible to register the patterns of various components of the patterns of behavior of the pair of eyes in motion. In a first group of six cases the patients present a predominantly hypokinetic form of acquired abnormality. In a second group of five patients the predominantly hyperkinetic disturbance was ascribed to labyrinthine or cerebral disturbance. In two further groups the patients had congenital anomalous patterns of motility. (11 figures, 33 references) F. H. Haessler.

Sachsenwanger, R. **The variability of the apparent angle of squint.** Arch. f. Ophth. **162**:166-177, 1960.

The angle of squint was measured photographically in 1339 subjects. The causes for the apparent position of the eyes were considered and various eye-types emerged. It was found that the magnitude of the apparent angle of squint has a statistically reliable relationship to the refraction. Eyes with myopic changes in the fundus have a smaller average angle than other myopic eyes. In the course of the first three decades the average size of angle decreases; after that a constancy of average value becomes manifest. There is no correlation between corneal refraction and apparent angle. (12 figures, 14 references) F. H. Haessler.

7

CONJUNCTIVA, CORNEA, SCLERA

Alberth, B. **Keratoplasty on the basis of an uncommon indication.** Szemszet **97**: 167-170, 1960.

Because of central leucoma the vision in both eyes of a patient with keratoconus was 0,5 with contact glasses after homatropine dilatation. Without pupillary dilatation the patient could see only the motions of his hand. The continuous use of drops caused a chronic blepharoconjunctivitis which healed only after discontinuing the drops. After bilateral keratoplasty vision of the patient's right eye improved to 0.7 and of the left eye to 0.6 with contact glass and without dilatation. His vision is 0.3 with common −30.0 D glasses.
Gyula Lugossy.

Bedrossian, R. H. **The effects of pterygium surgery on refraction and corneal curvature.** A.M.A. Arch. Ophth. **64**:553-557, Oct., 1960.

Excision resulted in an increase of the corneal curvature in the horizontal meridian in 45 percent of 50 eyes. The refractive error changed in 40 percent but this was variable and did not coincide with the change in corneal curve. (2 tables, 11 references) Edward U. Murphy.

Lister, A. and Dalley, V. M. **Multiple epitheliomata of the eyelids of one eye.** Brit. J. Ophth. **44**:638-639, Oct., 1960.

The authors report a case of epithelioma of the conjunctiva of the upper and the lower lids which occurred after prolonged

inflammation. It responded to radiotherapy. (4 figures) Irwin E. Gaynon.

Mathur, S. P. **Ocular changes in xeroderma pigmentosum.** Ophthalmologica **140**:33-36, July, 1960.

A single case is reported. In the course of the patient's disease, the corneas became opacified and keratinised, the conjunctiva became dry, ectropion developed with obliteration of the fornices, and the eyes became hypotonic.

Lawrence T. Post.

Ros, A. **Histopathology and therapy of trachoma.** Arch. d'opht. **20**:500-513 July-Aug., 1960.

The author reviews the literature on the histopathology and therapy of trachoma and describes a treatment of his own consisting of the local use of aspirin in aqueous solution or in neutral glycerine. He describes good results without documentation. In a review of the two subjects under discussion he lists a bibliography of 103 reports but offers no evaluation of the material presented. (103 references)

P. Thygeson.

Schwarz, A. and Elmiger, F. **Cogan's syndrome.** Confin. neurol. **20**:139-146, 1960.

Two cases are presented, one of Cogan's syndrome (non-syphilitic interstitial keratitis with cochleovestibular symptoms), and, for contrast, one demonstrating a similar symptom complex but associated with congenital syphilis. The former case was atypical 1. in appearing at the early age of six years, 2. in being associated during its acute phase with an ulcerative blepharitis and phlyctenular keratoconjunctivitis, and 3. in presenting the amazingly long interval of 22 years between the onset of the keratitis and the development of the cochleovestibular symptoms.

Lawrence T. Post.

Sie-Boen-Lian and Li-Shao-Chen. **A rare form of keratitis, isolation of a virus.** Ophthalmologica **140**:87-94, Aug., 1960.

A case of unusual keratitis in a 35-year-old man is presented. The disease was characterized by a 1 to 2 mm. wide, eccentric, incomplete circle (8 mm. in diameter) of deep, stromal infiltration without vascularization, and with an overlying epithelial edema. A corneal scraping stained with Giemsa revealed blue-black cytoplasmic inclusion bodies. The virus was cultured in embryo chick yolk sacs, and transmitted to guinea pig corneas (rabbits were not susceptible). A second case was later observed. The authors believe they have discovered a rare form of tropical and subtropical, viral keratitis, which has not as yet been classified. They differentiate it from Dimmer's nummular keratitis and state why they do not believe that they are dealing with a herpes virus contaminant. (5 figures, 15 references) Lawrence T. Post.

Szeghy, G. **The role of injury in the mechanism of experimental corneal vascularization.** Arch. f. Ophth. **162**:215, 1960.

Vascularization follows isolated areas of diathermic coagulation of the cornea of the rabbit's eye when the edema extends to the limbus. Checking the development of edema restrains or completely stops vascularization. Absence of continuity of the anterior semipermeable stratum alone —with the development of an edema— does not lead to edema. Thermically coagulated tissue per se does not bring about vascularization. (7 references)

Author's summary.

8

UVEA, SYMPATHETIC DISEASE, AQUEOUS

François, J., Rabaey, M., Evens, L. and Eliaerts, H. **Hemangioma of the choroid.** Arch d'opht. **20**:361-372, June, 1960.

The authors state that without the concomitant signs of glaucoma or retinal detachment, the diagnosis of angioma of the choroid is most difficult. They review the literature on the disease and mention possible localizing signs, including progressive hypermetropia with good vision, a posterior pole tumor with cystic degeneration of the retina, and minimal separation of the retina. They state that there is no difference between the isolated choroidal hemangioma and the angioma associated with the Sturge-Weber-Krabbe syndrome. They then report the histopathologic findings in an eye removed because of suspected malignant melanoma from a 53-year-old man. The tumor was not associated with nevus flammeus or with brain or meningeal involvement. In conclusion the authors analyze the reports in the literature on the results of treatment by means of diathermic coagulation or photocoagulation. The article is illustrated by seven plates in black and white and is accompanied by an extensive bibliography. (7 figures, 117 references)

P. Thygeson.

Lugossy, G. **Clinical fluorometry and uveitis-etiology.** Szemeszet **97**:157-161, 1960.

The examination of the permeability of the blood-aqueous barrier to fluorescein, or clinical fluorometry based on the method of Amsler and Huber could be successfully applied in the investigation of the etiology of uveitis. After the drawing of the fluorometric curve the patient must be examined carefully. If a focal infection is suspected a skin test is made with an extract of the questionable organism or antigen. If the fluorometry supplies enhanced values of permeability 48 hours after the positive cutaneous test, the focus is to be thought the cause. After its removal or after the desensitization the uveitis will heal. The fluorometry also is apt to elucidate a tuberculous etiology or a strepto-staphylococcus allergy. By applying this method, a dental focus was found in 30 percent, a focus in the tonsils in 10 percent, in the prostate in 16 percent, and a tuberculous focus in 36 percent, to which the uveitis was ascribed. Healing is to be assumed when, after the removal of the focus or desensitization and antibiotic treatment, the permeability to fluorescein decreases and gradually becomes normal. Gyula Lugossy.

Mathur, S. P. **Unilateral corectopia.** Brit. J. Ophth. **44**:574-575, Sept., 1960.

Corectopia is usually bilateral and symmetrical but the author describes a 30-year-old man with a normal right eye and a left eye which has the pupil displaced medially and also ectopia lentis, which is a frequent accompaniment of this condition. The vision of 2/60 was not correctible. (1 figure, 3 references)

Morris Kaplan.

Titschack, H. **The significance of mast cells in malignant melanoma of the choroid.** Ophthalmologica **140**:41-43, July, 1960.

It has previously been reported that the number of mast cells in sections of malignant melanomas of the choroid increases with duration of the disease. By careful cell counts in one slide each of 47 different melanomas, the author concludes that this is not the case, and that there is no relationship between the number of mast cells and the duration of the disease, nor between the number of mast cells and the age of the patient. Lawrence T. Post.

9

GLAUCOMA AND OCULAR TENSION

Draeger, J. **The dependence of the coefficient of scleral rigidity on the height of the intraocular pressure.** Ophthalmologica **140**:55-79, July, 1960.

This is a thorough, careful, and provocative piece of work from the University Eye Clinic of Hamburg. The concept of a

relatively constant coefficient of scleral rigidity (E) over fairly wide pressure ranges, as conceived of by Jonas Friedenwald, has been questioned in the past few years. Not only does it appear that certain drugs and water drinking can alter E, but Perkins and Gloster (Brit. J. Ophthal. 41: 93-102, 1957) suggested that minor variations in pressure in the normal ranges could themselves alter E significantly. The present study tends to confirm these somewhat disturbing observations.

The author studied spontaneous variations in E and intraocular pressure in some 300 eyes, both of normal and glaucomatous patients, rejecting all artificial means of varying the pressure (compression and massage of the globe, local or systemic drug action, and water-drinking) because of the likelihood of introducing new errors. The only thing which might conceivably make the reported observations at all suspect is the considerable magnitude of the change in E for the necessarily small, spontaneous fluctuations in eye pressure, e.g., for all the eyes considered together, a change from .0225 to .0190 for an increase of pressure of 4 mm.! However, evidence is presented to confirm a statistically significant decrease in E with rises of intraocular pressure, and the extent and direction of the change is irrespective of age, refractive state, glaucomatous disease, or previous surgery. Moreover, the putative decrease in E during the water drinking provocative test exactly coincides with the expected decrease simply from the rise of pressure, casting doubt on the concept of scleral imbibition of fluid. In like manner, the decrease in E with age can be explained.

These observations, which are of interest as far as routine tonometry is concerned, are of vital importance as regards tonography, where any error (or fluctuation) in E may cause grave misinterpretations. (11 figures, 9 tables, 23 references)

Lawrence T. Post.

Drance, S. M. **The significance of diurnal tension variations in normal and glaucomatous eyes.** A.M.A. Arch. Ophth. **64**: 494-501, Oct., 1960.

306 non-glaucomatous eyes and 138 untreated chronic simple glaucoma eyes were studied. An exaggerated phasic variation of the intraocular pressure in the glaucomatous eyes was seen in all stages of the disease and the value of this finding as a diagnostic sign in very early cases is discussed. (3 figures, 6 tables, 8 references)

Edward U. Murphy.

Klöti, R. **The use of urea in glaucoma therapy.** Ophthalmologica **140**:135-146, Aug., 1960.

In reporting 17 patients treated with urea, the authors join many others in enthusiasm for its effectiveness. They emphasize that urea is frequently effective in acute glaucomas when other drugs fail, that the pressure lowering effect is independent of the mechanism of the pressure elevation, and that there are practically no side effects. The mode of action is discussed. (9 figures, 15 references)

Lawrence T. Post.

Lugossy, G. **Clinical observations on the cause of functional symptoms in glaucoma.** Arch. d'opht. **20**:285-294, April-May, 1960.

The author concludes from a study of 300 cases of glaucoma followed over a period of years that insufficient reduction of ocular tension is the most important cause of continued loss of visual fields. In cases treated by the Blaskovics inverse cyclodialysis, by means of which a tension of 10 mm. of Hg or less was obtained, no losses in visual fields were noted. The role of arteriosclerosis of vessels in the optic nerve as a cause of deficient nutrition of the nerve, with increased sensitivity to hypertonus, is discussed. Illustrative cases are described in detail. (8 figures, 13 references)

P. Thygeson.

Luntz, M. H. and Smith, R. **A possible aetiology for glaucoma in Negroes.** Brit J. Ophth. **44**:600-605, Oct., 1960.

In Negroes glaucoma may be caused by a diffuse fibrosis of the episclera. This also explains the poor prognosis of many drainage operations. Pressure changes in the episcleral veins anticipate changes in intraocular pressure in glaucomatous eyes. The pressure in the aqueous veins is proportional to the intraocular pressure. When the intraocular pressure is increased the pressure in the episcleral veins will be higher than in the aqueous veins and the outflow is decreased. Four cases are reported. (18 references)

Irwin E. Gaynon.

Pena, Felix Sanchez. **A new operation for glaucoma.** Brit. J. Ophth. **44**:626-628, Oct., 1960.

The author describes his technique wherein, after making a limbus-based conjunctival flap, a guarded 10 mm. cyclodialysis spatula is inserted into the suprachoroidal space. The spatula is kept in place and a 2 mm. scleral T-shaped incision is made over the spatula. This joins the suprachoroidal and subconjunctival spaces. The iris is then grasped and a basal iridectomy is done. No cosmetic impairment of the eye results and the pupil is not deformed. The filtration bleb is behind the limbus. (1 reference)

Irwin E. Gaynon.

Urrets-Zavalia, A. **Goniotripsy: an operation for congenital glaucoma.** Ophthalmologica **140**:14-21, July, 1960.

From Cordoba, Argentina, comes a technique said to be particularly useful in the surgical treatment of congenital glaucoma, where corneal haziness makes direct observation of the angle with a contact lens difficult or impossible. A corneal incision is made parallel to and one millimeter from the limbus. The proximal lip of the wound is lifted with a hook and a specially designed, round-tipped knife is introduced into the angle on the same side. It is rotated vertically so as to scrape the angle (tripsis = rubbing) rather than to incise it.

Seventeen eyes of 12 patients were operated upon. Of 11 eyes without too marked corneal clouding, the procedure was successful in ten. Of the remaining six with marked clouding, four were successful. There were no complications, and, especially to be noted, there were no hemorrhages. Lawrence T. Post.

Vancea, P. **Essential progressive atrophy of the iris with secondary glaucoma.** Arch. d'opht. **20**:490-499, July-Aug., 1960.

Vancea presents a clinical study of two patients with progressive essential atrophy of the iris. The first case, in a woman of 60 years, was complicated by secondary glaucoma after three years and involved one eye only. The second case, in a patient of 25 years, began insidiously and without symptoms; the iris atrophy and glaucoma, again in one eye only, were detected in the course of a routine examination. In both cases treatment with miotics was unsuccessful but tension was normalized by cyclodialysis. In neither case were there field changes or cupping of the disc. The literature on the disease is reviewed in moderate detail. (2 figures, 23 references) P. Thygeson.

10

CRYSTALLINE LENS

Desvignes, P. and Behart. **Ocular hypertonus after operation for cataract.** Arch. d'opht. **20**:373-388, June, 1960.

The authors estimate that the frequency of glaucoma after cataract extraction ranges from 2.0 to 3.2 percent. From their analysis of cases they conclude that increased intraocular pressure is seen least frequently after uncomplicated intracapsular extractions, and most frequently after extracapsular extractions or in eyes

with torn capsules in attempted intracapsular extractions. Iridocyclitis from retained lens debris proved to be the most important cause. In their cases delayed formation of the anterior chamber was limited to one case in which iridocyclitis also occurred. The type of iridectomy or suture did not play a role, nor did vitreous loss. They conclude that the majority of post-cataract glaucomas are latent primary cases made manifest by the complication of surgery. (7 tables, 8 references)

P. Thygeson.

Dubler, H. **Saucer-shaped posterior brown cataract.** Arch. d'opht. **20**:389-401, June, 1960.

This condition was first described in 1922 by Vogt who found it in a 37-year-old woman who had had a parenchymatous keratitis at the age of 10 years. Although the cataract was saucer-shaped and deep, the posterior surface of the lens was relatively flat. The author reports four new cases, all with a history of congenital syphilis. In one of the cases extraction of the lens permitted a detailed histopathologic examination. It was possible to demonstrate by special stains the presence of mucopolysaccharides in the part of the lens that corresponded to the cataract. No pigment was demonstrated and the author concludes that the brown appearance was due to physical phenomena. He suggests that the cataract was due to disturbance of the lens metabolism in intrauterine life as a result of the syphilitic process. (7 figures, 7 references)

P. Thygeson.

Hill, H. F. **Technique of cataract extraction with alpha-chymotrypsin.** A.M.A. Arch. Ophth. **64**:601-605, Oct., 1960.

Experience with 58 selected cases is reported. This substance has definite value in patients between 20 and 60 years of age and tremendously increases the possibility of intracapsular extraction with a minimum of trauma. (11 references)

Edward U. Murphy.

Ludvig, I. and Örményi, I. **Meteoropathologic investigations of hemorrhage in the anterior chamber after cataract surgery.** Szemeszet **97**:149-156, 1960.

The authors examined the interdependence of hemorrhages in the anterior chamber and meteorological factors. Their observations revealed the necessity of a more precise analysis of meteorologic fronts and air masses. Vertical temporal sections should be taken in consideration in an increased degree. Gyula Lugossy.

Mehrey, M. P. and Pahwa, J. M. **Enzymatic zonulolysis. Alpha-chymotrypsin in cataract surgery.** Ophthalmologica **140**: 22-27, July, 1960.

One hundred cases of cataract extraction are reported from the Eye Hospital at Sitapur, India, in all of which alpha-chymotrypsin was used as an aid to surgery. Smith expression was found to be the procedure of choice. Vitreous was lost in seven instances, iris prolapse occurred in four, and the lens dislocated (presumably posteriorly) in four. The authors feel that extraction of the lens is simplified by the use of the enzyme, especially in younger patients, and that the incidence of retinal detachment in myopics is reduced. This latter contention is not supported by statistics in this article.

Lawrence T. Post.

Vörösmarthy, D. **The photocoagulation operation for cataract and secondary cataract.** Szemeszet **97**:134-140, 1960.

The author reports his operative procedure with photocoagulation for cataract, primary and secondary. He arranges the cases in three groups from the point of view of their operative solution. Each of these groups is delt with thoroughly on the basis of typical cases. The classifica-

tion was made by the pigmentation of the part to be coagulated. In nonpigmented cases the author first performs tinction with the patient's blood and then photocoagulates. Gyula Lugossy.

Weekers, R. and Pivont, A. **Extraction of cataract after fistulizing antiglaucomatous operations.** Arch. d'opht. **20**:257-264, April-May, 1960.

The authors describe in detail their technique for the extraction of cataract after fistulizing operations. This technique respects the filtration area. The incision is corneal at 12-o'clock and is made by keratome, with enlargement by scissors. Synechiae are broken by a spatula. Iridotomy is then performed, followed by enzymatic zonulolysis, extraction of the lens, and closure of the wound by corneoscleral sutures. The technique is illustrated by seven drawings in black and white. (7 figures, 18 references) P. Thygeson.

11

RETINA AND VITREOUS

Bailliart, J. **Clinical forms of senile macular degeneration.** Ann. d'ocul. **193**: 829-847, Oct., 1960.

Senile macular degeneration is divided by the author into three main groups. First, those degenerations which are of choroidal origin, secondly, those lesions which are of retinal origin, and finally a mixed group in which are the hereditary degenerations of the macula. Professor Bailliart lists the distinguishing characteristics of these three groups, but admits that they are very often difficult to differentiate. He feels that vasodilators are of some help in these diseases but that they are most effective in those of choroidal origin. (20 references) David Shoch.

Black, R. K. **Segmental lesions of the retinal arteries.** Brit. J. Ophth. **44**:562-566, Sept., 1960.

Three cases of uveitis are briefly described in which the retinal arteries showed well marked segmented white patches. These lesions persisted after the uveitis had been cleared. No explanation could be given for these deposits. (3 figures, 7 references) Morris Kaplan.

Blatt, N., Radian, A., Gadesco, P. and Regenbogen, L. **A clinical study on the inversion of a detached superior half of the retina.** Ann. d'ocul. **193**:817-828, Oct., 1960.

The authors report the case of a young man who was struck in the eye with a resulting retinal detachment. Examination showed an enormous disinsertion of the retina in the superior half, and a falling forward of this detached retina so that it overlay the inferior half of the retina. This gave the peculiar picture of a grayish mass below the area in which the retina was intact, and a reddish reflex above where the retina was completely gone, since this reflex is due to the underlying choroid. The diagnosis was made by the fact that the optic nerve was completely invisible.

Of particular interest is the fact that the patient had a monocular diplopia in this eye, which the authors ascribe to the fact that the inverted superior half of the retina was still capable of receiving an image, and therefore the patient saw one real image with the intact inferior portion of the retina, and a second inverted image with the detached and inverted superior half of the retina. (6 figures)

David Shoch.

Blodi, F. C. **Retinal involvement in idiopathic hyperlipemia.** Tr. Am. Acad. Ophth. **64**:720-725, Sept.-Oct., 1960.

Lipemia retinalis is due to an increase in triglyceride chylomicron, a lipoprotein of low density, in the serum. A case is reported in which the vision dropped to 20/80. The macula was markedly edematous, the periphery showed large yellow de-

posits, some of which contained blood, some arterioles were sheathed, and there was some pigment in the periphery. Both eyes showed some aneurysmal dilatation. The retina became detached, did not respond to diathermy or resection, and glaucoma occurred which led to enucleation. Pathologic study showed fat in and around the retinal vessels in all the layers of the retina and within some of the numerous cysts which were found in the retina. Possibly there is some relation to Coats' disease. (6 figures, references)

Harry Horwich.

Cameron, M. E. **Nontraumatic dialysis in the young.** Brit. J. Ophth. **44**:541-546, Sept., 1960.

In the aged there are several causes for dialysis whereas in the young this condition may occur rarely as a result of rupture of cysts at the ora or idiopathically with no known cause. During a period of 11 years 22 cases of this idiopathic dialysis were seen in the Brisbane General Hospital. Most of the patients complained of diminished vision but usually only after several months had elapsed; most patients were between 15 and 35 years of age and in most of them the dialysis occurred in the lower temporal quadrant. Of the detachments surgically repaired vision was restored to 6/9 or better in one third of the cases. The etiology is not known but two factors must be considered: a type of degenerative process in the extreme periphery of the retina, and internal forces such as the pull of accommodation. The author offers the further possible explanation in a difference in rate of growth between the pars plana and the peripheral retina resulting in a tendency toward separation at this point. (2 figures, 9 references)

Morris Kaplan.

Favre, M. **Macular hole and retinal detachment.** Ophthalmologica **140**:95-98, Aug., 1960.

A statement of Meyer-Schwickerath is cited to the effect that one of the chief reasons for developing photocoagulation was the possibility that it might be used for the treatment of macular holes, and that for this condition photocoagulation has proved both simple and very useful. The author boggles at the implications of this statement. He was able to find 44 cases of macular hole which had been studied at the Clinic in Berne in the past 15 years. None of these patients had developed retinal detachments. It is emphasized that detachments are very rare, that despite the presence of macular "holes" vision is frequently quite good, and that the vision may actually improve with time. He therefore warns strongly against photocoagulation for this condition unless a detachment is already present, since the procedure almost invariably is associated with marked loss of macular function. (1 table, 6 references)

Lawrence T. Post.

Michaelson, I. C. **Error and discovery in fundus disease.** Brit. J. Ophth. **44**:524-536, Sept., 1960.

The role of chance in scientific discovery should be minimized since achievement most usually is the result of brilliant and painstaking work; discoveries seem to occur in a logical sequence and in many fundus diseases both painstaking labors and this sequence of discoveries can be easily demonstrated. These steps or phases may be listed: 1. determination of a static fundus picture with the initial lesion unknown. 2. discovery by ophthalmoscopy of the initial lesion. 3. discovery of the events leading up to the initial lesion which usually involves reproducing it in laboratory animals. 4. application of these facts to experimental therapy in man.

In diabetes the first three phases have been accomplished and the fourth is still inadequate. In retinal detachment all four

phases are rather well studied and accomplished. In retrolental fibroplasia the entire picture is well understood and the studies followed the described sequence of events. In hypertensive retinopathy all of the phases have not fallen into place but the successes have followed the expected sequence. In disciform degeneration of the retina our knowledge is still confined to phase 1 since the initial lesion has not yet been determined. (59 references)

Morris Kaplan.

Molnar, L. **The applicability of electroretinography in surgery for retinal therapy.** Arch. f. Ophth. **162**:124-131, 1960.

Molnar discusses the significance of the b-wave of the electroretinogram in surgical therapy. The height of this wave supports a diagnosis in the presence of vitreous opacities, it helps in prognosis, and aids in evaluating the success of surgery by comparison of the height of the wave before and after surgery. (5 tables, 10 references) F. H. Haessler.

Renard, G., Fontaine, M. and Aron, J. J. **Chorioretinitis of Jensen.** Arch. d'opht. **20**:265-274, April-May, 1960.

The authors report 14 new cases of Jensen's chorioretinitis and review the 141 cases previously described in the literature. They conclude that the disease is a clinical but not an etiologic entity, and that it is characterized by a juxtapapillary retinal lesion with a peculiar scotoma. They conclude further that the lesion is often tuberculous but that other etiologic possibilities must be borne in mind. Of their 14 patients, eight had signs suggestive of tuberculosis, including positive tuberculin tests, phlyctenulosis, pulmonary infiltrates, pleurisy with effusion, and contact with active tuberculosis in the family. Only one had a positive serology for syphilis and in one the chorioretinitis followed a severe attack of influenza. As to therapy, the authors suggest antituberculous chemotherapy in cases having a presumptive tuberculous etiology and caution against the use of tuberculin therapy because of the danger of focal reactions. (1 table) P. Thygeson.

Rieger, H. **The etiology of retinitis exudativa externa centralis.** Arch. f. Ophth. **162**:178-192, 1960.

The author again describes this retinal lesion which he had first described in 1937 and 1939 and he briefly summarizes the literature on the relationship of this lesion to toxoplasmosis in the adult. He then reports 50 unselected cases observed by him. His analysis of the data leads him to conclude that this retinal lesion is a readily recognizable sign of acquired adult toxoplasmosis. (3 tables, 64 references) F. H. Haessler.

Schrader, K. E. **Lens clouding after electrocoagulation for retinal detachment.** Ophthalmologica **140**:98-104, Aug., 1960.

Only 22 eyes successfully operated upon for retinal detachment between 1945 and 1950 were available for reexamination at the time of this study. Of the 22, 11 showed lens opacities presumed to be related to the previous surgery. In most instances, the sector of the lens involved corresponded to the region of the globe subjected to electrocoagulation. The opacities consisted of both posterior and anterior subcapsular clouding. The probable mechanism of production of these cataracts is discussed. The progress of these lens changes is to be reported at a later date. (2 figures, 4 references)

Lawrence T. Post.

Schwab, P. J., Okun, E. and Fahey, J. L. **Reversal of retinopathy in Waldenstrom's macroglobulinemia by plasmaphoresis.** A.M.A. Arch. Ophth. **64**:515-521, Oct., 1960.

Two cases are reported. Elevated serum viscosity and macroglobulinemia can be corrected by this technique. Retinal hemorrhages and dilation and tortuosity

of the veins disappear relatively rapidly as do the systemic symptoms. (3 figures, 18 references) Edward U. Murphy.

Stobbe, J. A. and Keeney, A. H. **Role of lyophilized vitreous in experimental vitreous opacities of the rabbit.** A.M.A. Arch. Ophth. **64**:571-575, Oct., 1960.

Experimentally-produced vitreous hemorrhages in the rabbit, when treated by implantation of lyophilized and partially rehydrated vitreous, showed slightly faster clearing initially but essentially the same picture as the controls later. (9 references) Edward U. Murphy.

Tassman, W. S. **Ophthalmological reviews. Indications for light coagulation of the retina.** A.M.A. Arch. Ophth. **64**:616-617, Oct., 1960.

The conditions successfully treated include retinal detachments, peripheral retinal degeneration, selected intraocular tumors, Eale's disease, and Coats' disease. Iris coagulation may also be done to produce an optical iridectomy. (3 references) Edward U. Murphy.

Vannas, S. and Tarkkanen, A. **Retinal vein occlusion and glaucoma** Brit. J. Ophth. **44**:583-589, Oct., 1960.

There was a 42-percent incidence of simple glaucoma in patients with central venous occlusion. Three out of four patients older than 65 years and 10 percent of the patients with branch occlusion had simple glaucoma. Of 11 patients with unilateral hemorrhagic glaucoma nine had simple glaucoma in the opposite eye. Anticoagulant therapy gave a better visual prognosis. The discovery of hemorrhagic glaucoma or central vein occlusion calls for a most complete glaucoma study, including tonography, gonioscopy and the provocative tests. (4 tables, 1 figure, 22 references) Irwin E. Gaynon.

Ventura, J. and Mathieu, M. **Silver impregnation of whole retinas.** A.M.A. Arch. Ophth. **64**:528-535, Oct., 1960.

A modification of the Gros-Bielschowsky method was used to study flat unsectioned retinas from animals and man. (12 figures, 8 references) Edward U. Murphy.

Vesely, L. **Bilateral retinal detachment caused by cysticercus.** Ophthalmologica **140**:36-40, July, 1960.

An interesting case is reported of a gypsy boy with blindness of sudden onset at the age of two years. Examination revealed bilateral, fixed, funnel-shaped, retinal detachments. The retinas were grayish-white and opaque. The retinal folds were fixed, and the detachments did not transilluminate. There was a 12 percent eosinophilia. Withdrawal and examination of subretinal fluid did not aid in the diagnosis. Assuming the presence of a tumor one eye was enucleated. The other was subjected to five perforating diathermy punctures at the point of greatest elevation of the retina, and the subretinal fluid was drained. The enucleated eye revealed a subretinal, two-weeks-old cysticercus. Surprisingly, from the day of surgery the fellow eye improved, with reattachment of the retina and the eventual return of vision to 20/40. In previously reported cases the eyes had all been lost from panophthalmitis and no form of therapy had been of any benefit. In the case of the eye which recovered, the authors believe they had the remarkable good fortune of accidentally hitting the cysticercus during one of the diathermy perforations. Lawrence T. Post.

V. Sztanojevits, A. **Data on the diagnosis of retinitis exsudativa externa.** Szemeszet **97**:173-177, 1960.

In two cases the characteristic histologic picture (hyperplastic vascular anomalies, hemorrhages, mesenchymal reaction) made possible the diagnosis of retinitis exsudativa externa, but the clinical picture (yellowish color of the solid

ablation, phlebectases) had awakened suspicion of this diagnosis.

Gyula Lugossy.

Welch, R. B., Maumenee, A. E. and Wahlen, H. E. **Peripheral posterior-segment inflammation, vitreous opacities, and edema of the posterior pole.** A.M.A. Arch. Ophth. **64**:540-557, Oct., 1960.

Of 22 patients studied 15 showed massive exudation and seven diffuse inflammation. All were under 40 years of age and one third of the cases were seen in children. Etiology and therapy are discussed but in general the former is obscure and the latter of little benefit. The term "pars planitis" is suggested for this type of uveitis. (7 figures, 3 tables, 10 references) Edward U. Murphy.

Willemssens, P. and Henkes, H. E. **Treatment of senile macular degeneration with Rovigon and Heparinoid, Roche.** Ophthalmologica **140**:147-155, Aug., 1960.

The first of these preparations consists of a combination of Vitamins A and D in "high dosage." The second (undoubtedly a modified Heparin) is stated to be "known for its clearing effect in lipaemic plasma." Forty-six patients with various forms of macular degeneration were treated with one or the other of these preparations, or a combination of both. Fourteen patients were not treated and used as controls. Visual acuity was reevaluated six months later; an improvement of at least "1/10" was recorded in 25 percent. If "hopeless" cases were eliminated from the series ("complete atrophy of posterior pole, or fully developed disciform degeneration of the macula"), the percentage of improvement rose to 37 percent. So as not to have to rely entirely on subjective visual function tests, the authors attempted to correlate this improvement with changes in the visual fields, dark adaptation curves, and the ERG. However, they were forced to conclude that "perimetry, adaptometry, and electroretinography are of little significance in the objective demonstration of effective treatment." Nevertheless, they do not express themselves as concerned with the interpretation of these visual acuity data as do some other investigators. (3 figures, 1 table, 10 references)

Lawrence T. Post.

12

OPTIC NERVE AND CHIASM

Collier, M. **Anomalies of the optic nervehead in three successive generations.** Ann. d'ocul. **193**:881-887, Oct., 1960.

The author describes three generations in which anomalies of the optic nervehead occurred. The propositus had an epipapillary membrane on the left disc and a slight narrowing of the right palpebral aperature. Her two sisters showed cilioretinal arteries, and one of these sisters, a cafe-au-lait spot. The mother of these children showed a congenitally dilated vein on the left optic nervehead with a choroidal nevus in the paripapillary area; their grandmother a congenital venous dilatation with a protrusion of the veins into the vitreous in the right eye. There was also amblyopia of the left eye. (6 figures, 5 references) David Shoch.

Gros, C. and Cazaban, R. **Neurosurgical indications in lesions of the optic nerves.** Ann. d'ocul. **193**:848-859, Oct., 1960.

The authors discuss the indications for surgical intervention in two types of diseases of the optic nerve. These are optic atrophy and papillitis. In patients with optic atrophy they feel that surgical intervention is indicated if there is a history of trauma, and an abnormal cisternogram. In addition, one should operate if a diagnosis of cranio-stenosis can be made before permanent changes have taken place. Finally, if a definitive diagnosis of chiasmal arachnoiditis on a tuberculous basis can be made, relief of the pressure will improve the condition of the optic nerve.

The indication for interference in cases of papillitis is the failure of the usual anti-infectious and hormonal therapy. (7 references) David Shoch.

Kennedy, C. and Carroll, F. D. **Optic neuritis in children.** Tr. Am. Acad. Ophth. **64**:700-712, Sept.-Oct., 1960.

Less than two cases of optic neuritis in children were seen at this medical center per year. Of 41 cases, 22 were due to an unknown cause, eight to multiple sclerosis, four to Leber's disease, two each to congenital syphilis and malnutrition, and one each to measles, diabetes, and Schilder's disease. Case histories are presented on all except those in the first group.

Tabulations were made of associated conditions of possible etiologic significance, other symptoms occurring with visual failure, disc findings, visual field defects, visual acuity, treatment, recovery time, and time for multiple sclerosis to appear. It was found in this series that children had headache more frequently than adults, had bilateral disease more commonly, and had a greater frequency of papillitis than retrobulbar neuritis. (9 tables, 35 references) Harry Horwich.

Machado, N. R. **Glioma of the optic nerve.** Arq. brasil. de oftal. **23**:31-40. 1960.

A 24-year-old woman had noted gradual loss of vision and proptosis of the left eye for about seven years. Examination revealed a divergent, congested globe which protruded 12 mm. beyond the fellow eye. The optic nerve head was pale and retinal striae suggested the presence of a mass behind the globe. Radiographic examination revealed an enlarged optic foramen but did not demonstrate any tumor. Because the patient had severe pain in the forehead and behind the eye, the eye was enucleated and a tumor involving the entire orbital portion of the optic nerve was found. Histologic examination showed the tumor to be a fusiform glioma of the optic nerve. Although intracranial extension was feared, the patient refused a craniotomy. (5 photographs, 14 references) James W. Brennan.

Wright, P. **Meningocoele of the optic disc.** Brit. J. Ophth. **44**:570-571, Sept., 1960.

In the otherwise normal eye of a young man minute herniation appeared within the optic disc and extended slightly into the vitreous. Pressure on the globe collapsed this lesion while pressure on the jugular vein caused its distension. It was concluded that the lesion was an arachnoidal hernia in free communication with the intracranial subarachnoid space. (1 figure) Morris Kaplan.

13
NEURO-OPHTHALMOLOGY

Ferreira Lopes, A., Fernandes, A. G., Ataide, L., Benico, A. and Chavez Batista, A. **Ocular symptoms caused by cryptococcus meningitis.** Arq. brasil. de oftal. **23**:49-55, 1960.

A 28-year-old man had headaches and giddiness for a month prior to examination. There was marked loss of vision in each eye and papilledema. Cryptococcus neoformans was recovered from the spinal fluid. He was treated with mycostatin and amphotericin, with the additional complication of increasing amounts of blood urea. About four months after admission, the patient was discharged from the hospital as cured, although there was a tendency toward optic atrophy. There is no record of final visual acuity or visual fields. (3 figures) James W. Brennan.

Forgacs, J. **Ocular alterations in experimental lathyrism due to IDPN.** Arch. d'opht. **20**:275-284, April-May, 1960.

Forgacs presents a study of experimental lathyrism in rats induced by iminodiproprionitrile (IDPN) which constitutes an extension of the studies of H. Selye (Am. J. Ophth. 44:763-765, 1957). Lath-

yrism is defined as a neurologic disease, known since antiquity, provoked by ingestion of an excess of certain pod vegetables and characterized by tremors, weakness, and paresis or rigidity of the extremities which produces a characteristic spastic gait. The principal ocular symptom has been a hemeralopia. The author induced neurolathyrism in female albino rats. The eye changes included parenchymatous keratitis, hemorrhages, and exudates in the anterior chamber. The corneal and iris changes are illustrated by photomicrographs depicting their histopathology. (3 tables, 7 figures, 4 references) P. Thygeson.

Goldstein, J. E. and Cogan, D. G. **Diabetic ophthalmoplegia with special reference to the pupil.** A.M.A. Arch. Ophth. **64**:592-600, Oct., 1960.

Third nerve ophthalmoplegia was seen in 20 diabetic patients; sparing of the pupil was present in 17. Of the five patients with pupillary involvement four had an incomplete iridoplegia and the other one a complete internal ophthalmoplegia. This is in contrast to the usual disturbance of the pupil with tumors and aneurysms. (1 table, 14 references)

Edward U. Murphy.

Henderson, J. W. **Annual Reviews. Neuro-ophthalmology.** A.M.A. Arch. Ophth. **64**:618-643, Oct., 1960.

The literature for 1959 and early 1960 is surveyed. (199 references)

Edward U. Murphy.

14

EYEBALL, ORBIT, SINUSES

Converse, J. M. and Smith, B. **Blowout fracture of the floor of the orbit.** Tr. Am. Acad. Ophth. **64**:676-688, Sept.-Oct., 1960.

This entity is described in detail. It is characterized by a compressing blow at the opening of the orbit, forcing some of its contents through the thin bone in the posterior half of the floor. Enophthalmos occurs from loss of orbital fat, and diplopia occurs from incarceration of the inferior oblique and, the inferior rectus muscules and their fascia. The weak area in the floor is demonstrated by transillumination. Typically the rim is not broken, although cominuted fractures may occur. The fracture occurs posteriorly where the thin floor is further weakened by the infraorbital canal or groove. Particularly vulnerable at this site is the vein to the inferior oblique muscle.

Diagnostic manifestations, aside from ecchymosis and edema, are enophthalmos, deepening of the supratarsal sulcus, restriction of rotation upward, downward and laterally, a positive traction test for incarceration of the inferior rectus muscle, anesthesia or hypesthesia in the cheek, a cloudy antrum on roentgenography, and finally, visualization of the fracture through a Caldwell-Luc approach.

In the discussion of the treatment it is stressed that mere elevation of the floor by packing, balloon, or bone graft is not enough, one must prevent adhesion of the orbital contents to the floor. Relief of diplopia may occur immediately or over a period of several months. The earlier the surgery is done the more rapid is the return to normality. (9 figures, 6 references) Harry Horwich.

Erbakan, S. **Peritoneal graft in extremely retracted conjunctival sac.** Brit. J. Ophth. **44**:558-561, Sept., 1960.

Numerous mucosal and skin materials have been used for conjunctival repair and one of the most satisfactory procedures has been the use of peritoneal tissue removed from inguinal hernias. The author briefly described three cases of repair of sockets retracted too greatly to allow insertion of a prosthesis. In all three cases the sockets were satisfactorily repaired

with peritoneal tissue from an inguinal hernia. (6 figures, 4 references)

Morris Kaplan.

15

EYELIDS, LACRIMAL APPARATUS

Baclesse, F. and Dollfus, M. A. **Roentgen therapy of palpebral cancer.** Arch. d'opht. **20**:473-489, July-Aug., 1960.

The authors report 556 cases of lid cancer treated at the Fondation Curie by contact therapy (50 kV) for small lesions, and by deeper therapy (150 to 180 kV) for more extensive ones. In a five-year follow-up, 405 patients were living and their lesions apparently healed. There were 136 patients with recurrence in the series that required a second radiation, and of these 91 were living and healed after five years. Thirteen of 24 failures were cured by surgery. The authors describe the technique and dosage of radiation in considerable detail. The complications of treatment included cataract and secondary glaucoma (from contact therapy, 0.7 percent cataract and 0.3 percent glaucoma; from deep therapy, 1.5 percent cataract and 3.0 percent glaucoma). They conclude that radiotherapy is the treatment of choice for palpebral cancer. (6 tables, 12 figures) P. Thygeson.

Hudomel, J. **Ten years' experience with dacryocystorhinostomy.** Szemeszet **97**: 141-149, 1960.

The author reports 711 operations performed on the lacrimal sac at the II. Ophthalmological Clinic in Budapest during the last ten years. He tabulates the kind of operation and the results obtained. In more than 80 percent of cases good and lasting results were obtained.

Gyula Lugossy.

Pierce, M. K., Goldberg, J. L. and Brooks, C. J. **A direct approach for transposition of the parotid duct.** A.M.A. Arch. Ophth. **64**:566-570, Oct., 1960.

Two cases of severe xerophthalmia were treated by transplanting the parotid duct and adjoining mucous membrane intra-orally to the conjunctival sac. A skin incision is eliminated by this technique and a duct of adequate length is easily obtained. (7 figures, 14 references)

Edward U. Murphy.

16

TUMORS

Hobbs, H. E., du Boulay, G. and Davis, R. E. **Orbital angioma diagnosed by phlebography.** Brit. J. Ophth. **44**:551-557, Sept., 1960.

It is generally accepted that hemangiomata of various types probably account for most of the cases of unilateral proptosis. The diagnosis of these tumors has been difficult until progress has been great as well as damaging. Radiography has until recently been of limited help, since the venous system could be demonstrated poorly. However, opacification of the orbital veins by injection of the medium into the angular vein makes the orbital venous pattern easily visible and usually cavernous hemangiomata can be diagnosed with considerably greater certainty.

A 20-year-old patient had had proptosis of one eye for 16 years with no definite diagnosis. A phlebogram via the angular vein demonstrated the presence of a hemangioma which was subsequently removed. The technique involves simple injection of the opaque substance through the skin into the vein using a very fine needle. (6 figures, 13 references)

Morris Kaplan.

NEWS ITEMS

EDITED BY DONALD J. LYLE, M.D.
411 Oak Street, *Cincinnati 19, Ohio*

News items should reach the editor by the 10th of the month. For adequate publicity, notice of postgraduate courses and meetings should be received three months in advance.

DEATHS

Dr. Maurice C. Landau, Glens Falls, New York, died September 14, 1960, aged 50 years.

Dr. Jacob John Mann, Perth Amboy, New Jersey, died September 13, 1960, aged 67 years.

Dr. Harry Theodore Schiefelbein, Welch, West Virginia, died August 17, 1960, aged 63 years.

ANNOUNCEMENTS

CONTINUATION COURSE

From May 1st through 3rd, "Ophthalmology for specialists," will be presented as one of the medical continuation courses at the Center for Continuation Study, University of Minnesota Medical School, Minneapolis. For further information concerning the courses write to: Director, Department of Continuation Medical Education, 1342 Mayo Memorial, University of Minnesota Medical School, Minneapolis 14.

WASHINGTON HOSPITAL CENTER

During April, the lectures offered by the Department of Ophthalmology, Washington Hospital Center, Washington, D.C. will include: Saturday, April 1st, "Sensory disturbances," Dr. Dan G. Albert; April 8th, "Amblyopia," Dr. Hermann M. Burian; April 15th, "Sensory disturbances" (continued), Dr. Dan G. Albert; April 22nd, "Motor disturbances," Dr. Donald J. Lyle; April 29th, "Vergences," Dr. Marshall M. Parks.

TREACHER COLLINS PRIZE ESSAY

Under the above title, the Council of the Ophthalmological Society of the United Kingdom has instituted a prize of £100, awarded triennially, for the best essay submitted upon a subject selected by the council. The prize shall be open to qualified medical practitioners of any nationality. The essay shall be written in the English language. The subject for the next award of the prize is "Demyelination and the eye."

The winning essay may be published in the *Transactions* of the Ophthalmological Society, if the council so desires. The closing date for sending in essays for this award is December 31, 1962. Essays should be submitted to the Honorary Secretary, Ophthalmological Society of the United Kingdom, 47 Lincoln's Inn Fields, London, W.C.2, from whom also any further particulars can be obtained. No name should be on any essay, but a distinguishing pseudonym or quotation, which should be upon a sealed envelope containing the candidate's name and address, should accompany the essay.

SNELL LECTURE

The sixth annual Albert C. Snell Memorial Lecture will be given in Rochester, New York, on May 10th by Dr. Harold G. Scheie of the University of Pennsylvania. Dr. Scheie's topic will be "Filtering operations for glaucoma." An afternoon clinical session will be held at the University of Rochester Medical Center, to be followed by a dinner and Dr. Scheie's presentation at the University Club in Rochester.

SOCIETIES

WEST VIRGINIA

The 14th annual meeting of the West Virginia Academy of Ophthalmology and Otolaryngology will be at the Greenbrier Hotel on April 6th, 7th, and 8th. The program will include:

Harvey E. Thorpe, Pittsburgh, "Recent developments and personal experiences in cataract surgery"; John J. Shea, Memphis, "Fenestration of the oval window after five years" and "Vein graft tympanoplasty"; F. Johnson Putney, Philadelphia, "Laryngeal keratosis: A clinicopathologic problem" and "Neck dissection in cancer of the larynx"; Irving H. Leopold, Philadelphia, will give two lectures, the titles to be announced later. Arrangements have been made with Mr. Philip Salvatori of Obrig Laboratories to discuss the fitting of contact lenses.

A special convention rate will be available at the Greenbrier. There is a nonmember registration fee of $25.00 to cover all the social and scientific sessions, which entitles graduate doctors of medicine to associate membership in the academy. For further information write to Worthy W. McKinney, M.D., secretary-treasurer, 109 East Main Street, Beckley, West Virginia, or write directly to Reservation Manager, The Greenbrier Hotel, White Sulphur Springs, West Virginia.

BROOKLYN

The Brooklyn Ophthalmological Society, at its 159th regular meeting, heard the following scientific program: Panel discussion: "Tumors and reconstructive surgery of the orbit," moderator, R. C. Troutman; speakers, Peter Ballen, Gordon J. Cole, John Simonton and Byron Smith.

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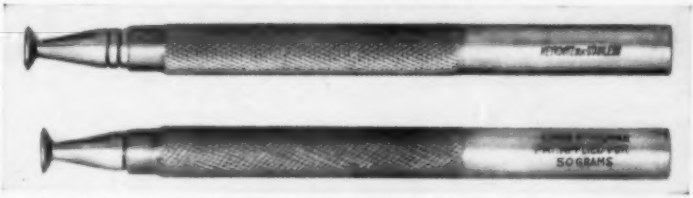

In the normal eye, prolonged external pressure will cause a substantial decrease in intraocular pressure. This condition is commonly noted in tonometry. In the glaucomatous eye because of reduced outflow, the loss in tension from compression is less. The difference is so great that in comparison to the normal eye, glaucoma may often be diagnosed in the early stages.

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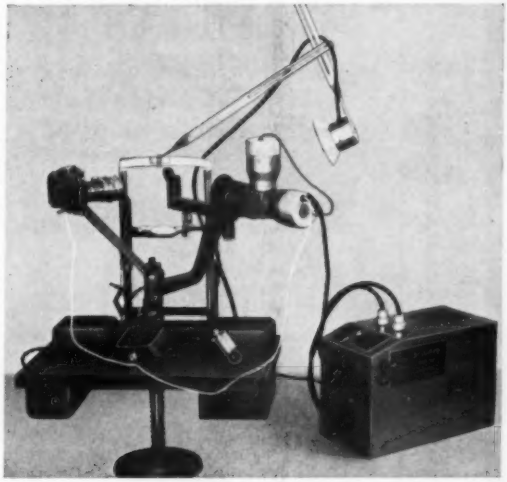

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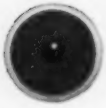

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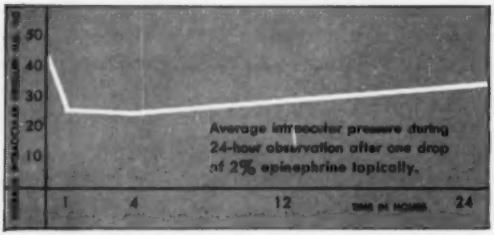

2 "The removal of epinephrine [GLAUCON] topical therapy from 43 eyes previously stabilized and normalized on combined therapy [GLAUCON and a miotic] and permitted to be without this medication for a period of seven days results in a rise in the intraocular pressure ranging from 4 mm. Hg to 31 mm. Hg with an average rise of 11.7 mm. Hg. It is in this group that the greatest number of satisfactory results were noted . . ."

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1. Garner, L. L.; Johnstone, W. W.; Ballintine, E. J.; and Carroll, M. E.: Effect of 2% Levo-Rotary Epinephrine on the Intraocular Pressures of the Glaucomatous Eye. A.M.A. Arch. Ophth. 62:230 (Aug.), 1959.

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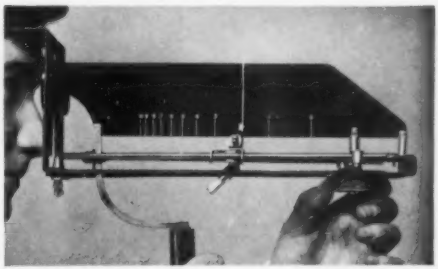

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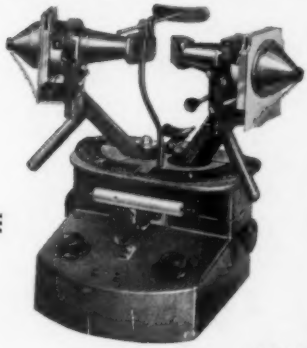

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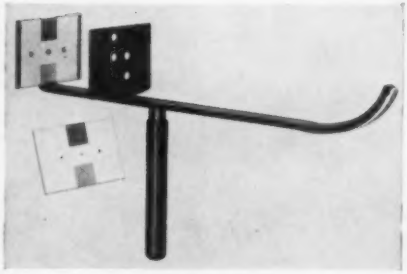

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